

# Annual Review Number of

## THE IRON AGE

January 7, 1937

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Published every Thursday. Subscription  
Price: United States and Possessions, Mexico, Cuba, \$6.00; Canada, \$8.50; Foreign \$12.00 a year.  
Single copy, 25 cents. This issue, \$2.00.

Cable Address, "Ironage, N. Y."

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CHILTON COMPANY  
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Executive and Publication Offices, Chestnut and 56th Sts., Philadelphia, Pa.  
Sales Offices, 239 West 39th Street, New York, N. Y.

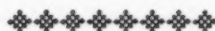
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# THE IRON AGE

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# THE IRON AGE

ESTABLISHED 1855

JANUARY 7, 1937

Vol. 139, No. 1

## L'Envoi

ON the following pages you will find recorded the progress of our industry in its many branches during 1936. It has been a pleasurable and inspiring task for us to compile this review of commercial and technical development, more so than usual. For it has been accompanied by the hum of more and more wheels turning, the rhythm of an augmenting volume of workers' footsteps, the jingle of more coins in the pay envelope and in the cash register and the crescendo of increasing activity.

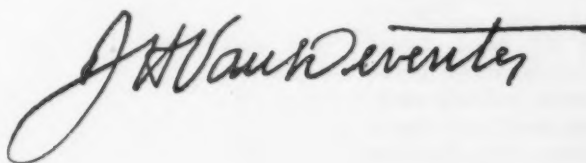
Before you turn to the story of what has happened in the plants of America, however, let us dwell for a moment on what has happened to the mind of America. For the two are as inseparably linked, in cause and effect, as are the chicken and the egg.

As confidence advances, fear retreats. And it matters not who blows the bugle for the charge.

Not so long ago, America was faced with a spirit of defeatism. In the minds of many we had reached the end of the blind alley of progress. Never again would our steel mills and factories be taxed to capacity to provide for human wants. Never again would there be enough room for workers and machines to labor together in our plants. We would have to put a brake upon invention and improvement; redistribute poverty and accept a lower standard of living; level men down instead of building them up.

This issue of THE IRON AGE is, I think, a complete refutation of the dismal doubts of defeatism. The spirit of defeatism could never have made possible the splendid story of industrial progress in 1936 that is recorded in our pages. No one can read it without the conviction that the undaunted spirit of men without fear has been at work among us.

To these men America owes a debt that can only be repaid by loyally following their leadership in the march toward more and better things for all of us.



# PROGRESS

By E. G. GRACE

*President of Bethlehem Steel Corp.*

• • •



THE editors of *THE IRON AGE* have graciously invited the writer to present a viewpoint on the progress and trends in the steel industry.

Anyone who seeks to predict tonnage figures for a given period is courting trouble. There are too many factors in world economics which can upset the predictions of the most prudent, as experience has demonstrated.

The trend of our business, however, is measured by more factors than those of tonnage figures alone. In fact, the present trend is not in emphasis upon production, but in the wise management of productive facilities.

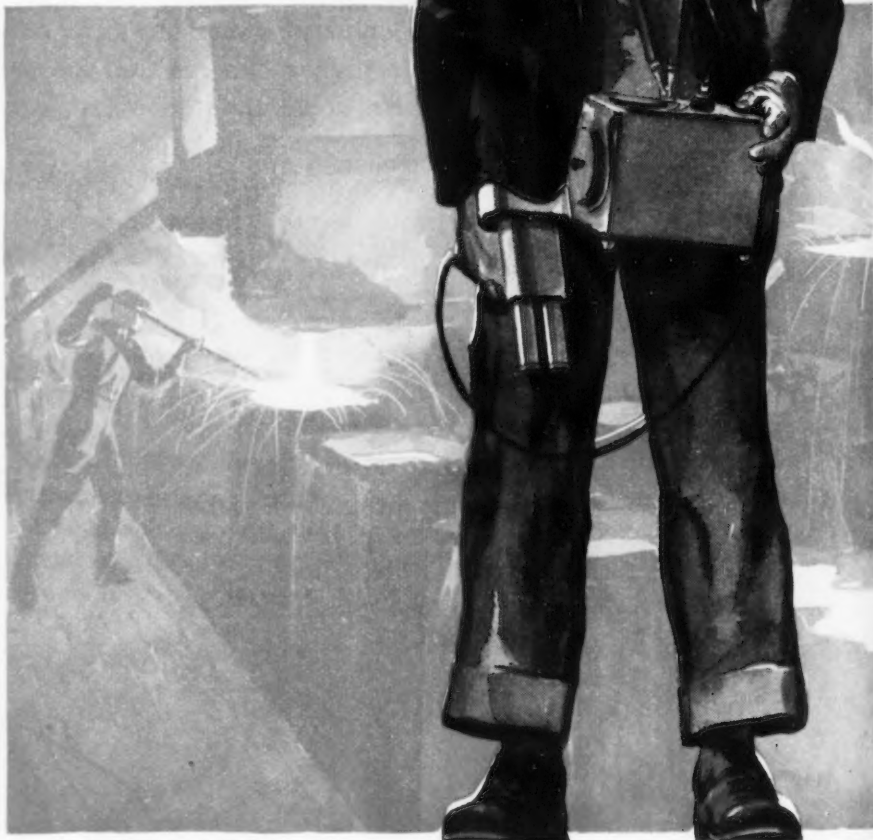
As I see it, the future of our business structure in all phases of the steel industry, whether in the mills or in the fabricating of steel products, will be influenced very strongly by the way in which management proves itself able to deal with the new conditions of the times. Therefore, I would like to present some of the problems and opportunities which management must handle effectively if the steel industry is to progress to its full potentialities.

## Change in Nature of Steel Business

THE steel industry has gone through its highly constructive era in building new facilities. We are now in an era of management, where the chief job is to har-

monize and balance production facilities. We must harmonize these facilities not only in respect to well rounded production schedules, but also in relation to the total activity of our national life. Management must think more broadly. It must comprehend and advance in its relationships to the customer, the investor, the employee and the public.

I believe that the steel industry has taken a new lease on life. We have become more consumer-minded. The range of interests to which we are supplying steel has extended widely. Formerly we served a few big capital investment industries, now we serve the man in the street. Where previously our production was chiefly



# IN STEEL

on behalf of such groups as the buyer of railroad materials and the purchaser of office buildings, today we sell to the man who rides on the railroad and the man who works in the office building.

## New Phases of Consumers' Goods

WE have these new popular markets for light steel products. We have spent huge sums of money for the machinery to make these products and to broaden our markets. And now we should appraise this new condition in the terms of its gains and its responsibilities.

One advantage is immediately clear. Consumers' goods have less drastic fluctuations than capital

goods. Steel has diversified its markets and thereby minimized its risks. It is possible at last to get rid of the notion that steel is either "a prince or a pauper." There should be no more pauper days in the steel industry. In future hard times we may need to tighten our belts a few notches, but we should no longer experience the terrific drops of past depressions.

## Better Commercial Policies

WIDER markets bring wider responsibilities. As we serve a much larger range of trade, management in the steel business must become more public-minded. Steel companies have lacked constructive commercial policies on which the buying public and investor could depend. The open price system, which has only recently come into practice, is a step in the right direction. We must have commercial policies in which the general public has solid confidence. This means fair prices to all so that each purchaser of material knows where he stands in relation to his particular competition.

## Social Progress in Industry

BUSINESS has a trusteeship to the investor, to the general public and to the employee. Management's conduct of that trusteeship must recognize all three of those elements of its responsibility.

In its employee relationships the steel industry has had in recent years a progressively more enlightened attitude. Vacations with pay for mill workers have been instituted recently in many companies. Steel has been a leader in the reemployment of manpower, even though with drastically curtailed operations it went the limit in avoiding layoffs during the depression. Today the



steel industry employs 50,000 more men than at the peak of 1929.

I do not mean to say that the steel industry should claim that it has a broader feeling of responsibility to its employees than have other industries. I wish merely to point out that for some time steel has assumed leadership in many social minded principles which have been adopted by the general public as the proper trend for our times.

#### 40 Per Cent Over 40 Years

TAKE the question of the age of workers at either end of the scale. There is no child labor problem in the steel industry.

And the steel industry especially values and encourages long-service employment. In fact, the company which I represent has recently made a tabulation of the ages of its personnel which, I believe, typifies the condition in the steel industry. Here it was found that the average age of the more than 85,000 employees was 37 years, indicating a fine balance between the older and younger heads, so to speak; and over 40 per cent of the total were more than 40 years of age.

Take the question of the man's creative interest in his job. Management has a responsibility to so conduct the affairs of industry that the employee will be, and will feel himself to be, not a cog but a creative part of the enterprise.

The cooperative labor policies, the close mutual relationship be-

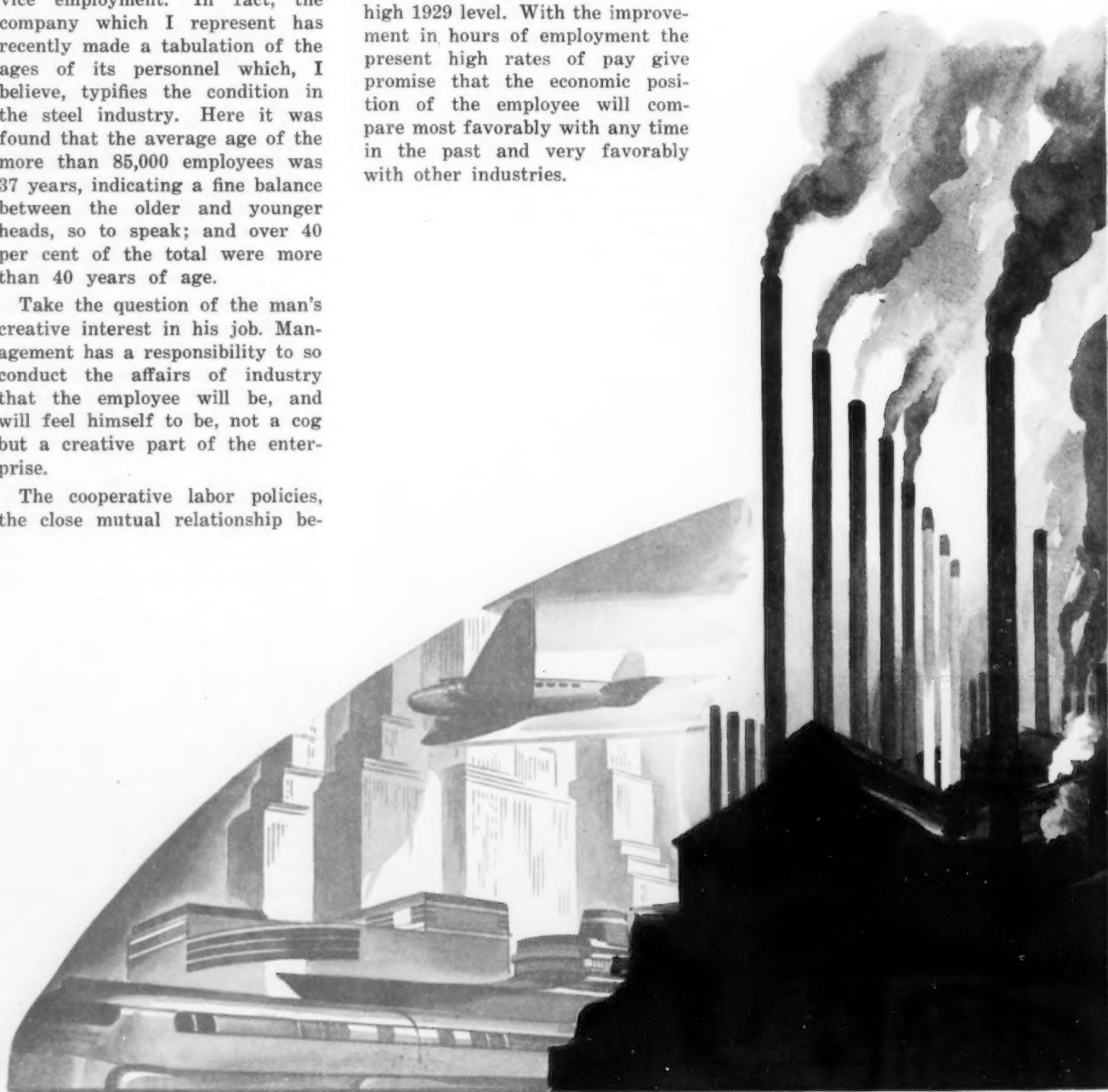
tween steel management and employees, have served to develop a personnel of the highest order; in fact, through enlightened employment policies and broad training programs, they have developed the highest creative types among American workers. Every man in a steel organization plays his responsible part in it and this contribution is recognized and encouraged.

#### Importance of Personnel

THIS cooperative understanding between management and men extends to the basic problem of wages. Various wage increases for employees have taken place since the low point of the depression until the rates now average about 20 per cent above the high 1929 level. With the improvement in hours of employment the present high rates of pay give promise that the economic position of the employee will compare most favorably with any time in the past and very favorably with other industries.

Through the plans of employees' representation now operating in most companies of the industry means have been provided for collective bargaining not only on questions of wages, but also for dealing with many other matters which affect the economic security of the employee in his job.

Management must continue to progress in social mindedness. The trend of the times is for the worker to have as large a participation in the enterprise as conditions will



permit. This is as it should be. It will be written down in history as a credit to our age. But we must accept the responsibility for keeping in proper balance all the factors involved.

#### Reward for the Investor

**A** BUSINESS cannot continue to exist which turns over all of its revenues to one claimant, to the exclusion of the others. That is where management must balance its responsibilities to the

public, to the employee and to the investor.

I am hopeful that the patient investor will soon receive a more equitable return on his savings than he has for some time past. It is a chief part of management's job to exert every effort to keep costs in line so that revenues will be adequate for the payment of dividends to the stockholders who have invested their savings in the industry.

This is a task which will require the utmost ability. The latest wage advance will add approximately \$75,000,000 to the annual payroll of the industry. Taxes, too, are at high levels. In the ore operations, for example, taxes take 27c. of every dollar. The added taxes all along the line for social security and other purposes present cost conditions which are new problems to be dealt with to an extent greater than ever before.

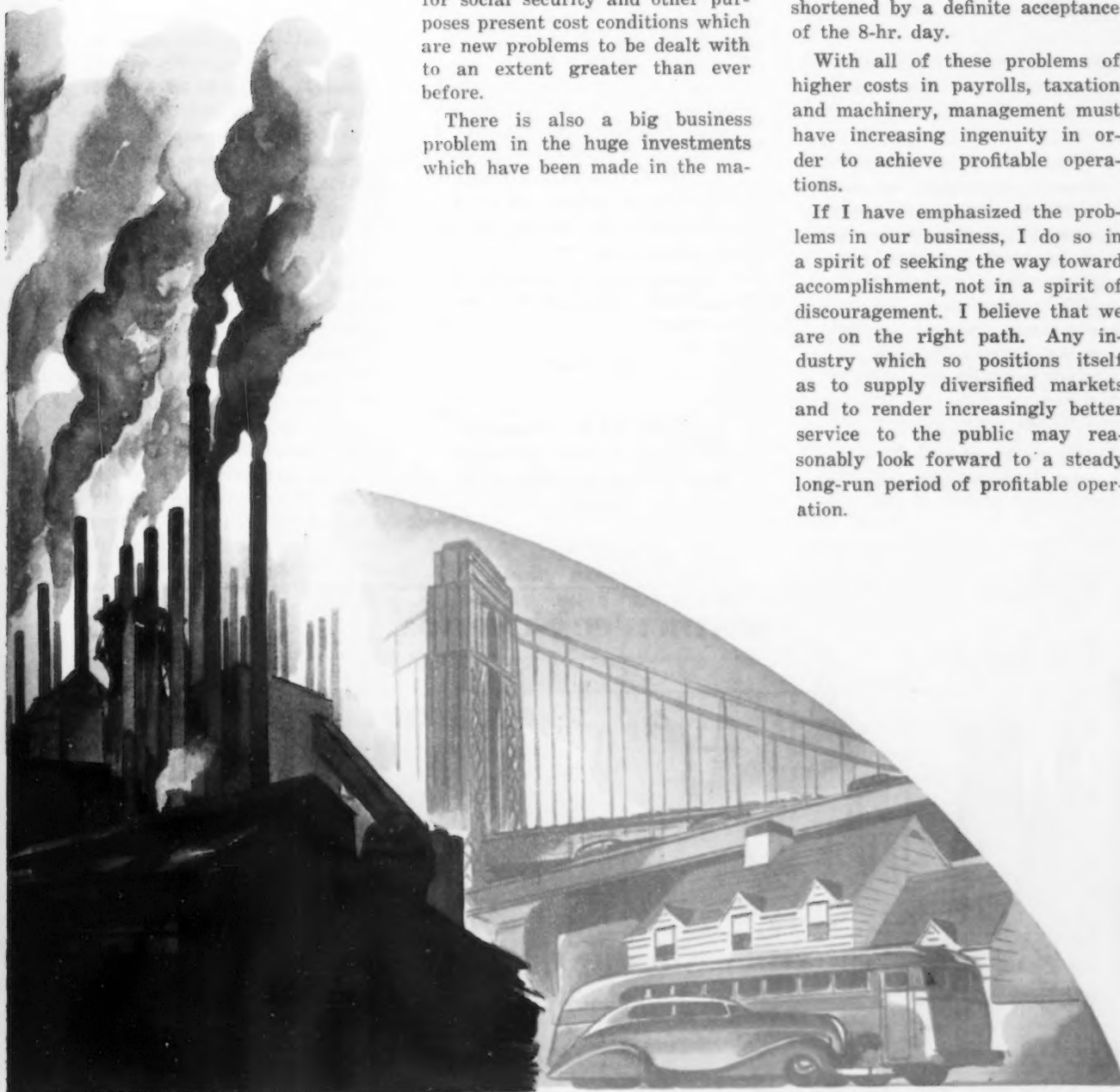
There is also a big business problem in the huge investments which have been made in the ma-

chinery for producing consumers' goods. This investment has made possible the new volume markets. It has not, however, lessened the payroll problem over previous years. This technological improvement has neither reduced the number of employees nor even lowered the number of employees per ton of output. In 1929, daily production was 175,000 tons and in 1936, 146,000 tons, yet there were 50,000 more persons employed at the end of 1936 as compared with 1929.

It is a healthy thing that improved machinery has brought improved employment. This is due in part to the fact that the lighter and finer grades of steel require more man hours of labor. Then, too, the work week has been shortened by a definite acceptance of the 8-hr. day.

With all of these problems of higher costs in payrolls, taxation and machinery, management must have increasing ingenuity in order to achieve profitable operations.

If I have emphasized the problems in our business, I do so in a spirit of seeking the way toward accomplishment, not in a spirit of discouragement. I believe that we are on the right path. Any industry which so positions itself as to supply diversified markets and to render increasingly better service to the public may reasonably look forward to a steady long-run period of profitable operation.



# STEEL ENTERS A



**MEASUREMENTS** of the 1936 recovery in the iron and steel industry and its related branches portray the extent of the road that has been traveled back toward normal business conditions. The outstanding indices are:

Production of open-hearth and bessemer steel ingots was about 47,000,000 gross tons (December estimated), or nearly 69 per cent of the industry's capacity, based on the official rating of Dec. 31, 1935, but slightly below that when allowance is made for new steel-making capacity that went into service during the year. This was a 40.6 per cent gain over the 33,417,985 tons produced in 1935.

Pig iron output totaled approximately 30,750,000 gross tons (December estimated) of coke iron

and ferromanganese, compared with a little over 21,000,000 tons in 1935, a gain of about 46.4 per cent and representing an operation of about 62.8 per cent of the country's capacity in these grades.

Coke production was probably upward of 43,000,000 tons, available figures for 10 months showing an output of 36,107,940 tons, with the industry operating at around 3,500,000 tons a month. This year's output will show a gain of about 35 per cent over 1935.

Lake Superior ore shipments by water were 44,822,023 tons, the

largest since 1930 and a gain of 58.03 per cent over 1935.

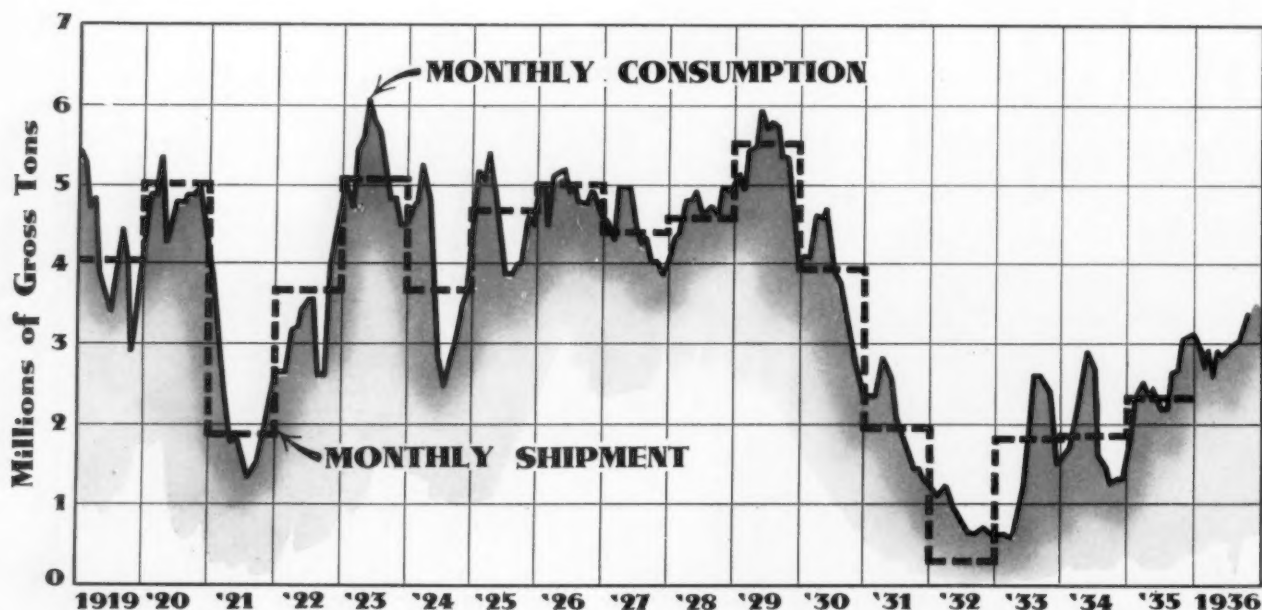
Steel scrap prices rose to new highs since 1925.

Automobile production, cars and trucks, in the United States and Canada totaled about 4,600,000 units compared with 4,182,191 in 1935 in an industry that had gained more than the average recovery in 1935.

Building construction, though still lagging in the recovery movement, represented expenditures of upward of seven billion dollars against an average of about 12 billions in the 1925-1929 period and about double the low point in 1933.

Railroad equipment and rail orders were the largest since the late twenties and car loadings, one of the best indicators of the volume of general business, in the

## MONTHLY consumption of iron ore compared with monthly shipments



# NEW CYCLE

By C. E. WRIGHT  
Managing Editor, *The Iron Age*

October peak reached 71½ per cent of the 1925-1929 average.

Machine tool orders in the year well exceeded the 1926 average (National Machine Tool Builders' Association base) and in a few months went over the 1928 average.

Prices of finished steel at the end of the year approximated the high point of 1929 and pig iron prices were the highest since early 1927.

THESE indicators received much of their upward push in the last half of 1936 and particularly in the final quarter, with sufficient momentum at the beginning of the new year to carry the recovery movement further forward.

Steel production made the amazing record of exceeding all past years excepting 1928 and 1929, the former year surpassing the 1936 record by only 7.4 per cent and the latter by 13 per cent, notwithstanding the fact that in two months of

1929 the industry operated at 100 per cent, a feat never equaled before or since. The peak daily rate of that period—198,062 tons—was only a little more than 14 per cent above the November, 1936, daily average of 173,496 tons. The December output, official figures for which are not available at this writing, will more closely approach the all-time record.

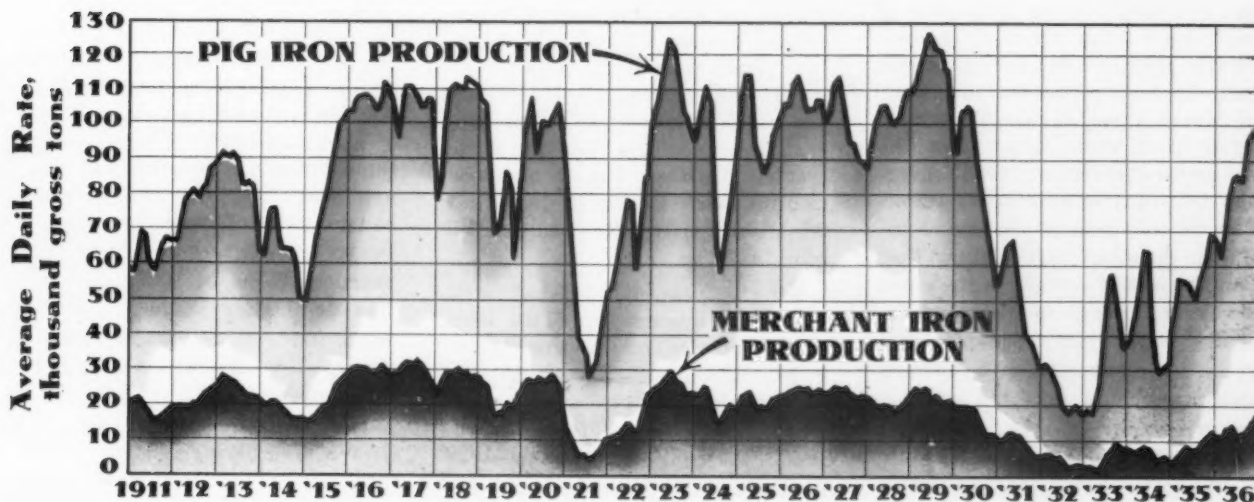
Notwithstanding the unusual recovery record, the year did not start auspiciously for the steel companies. The average rate of production in the first quarter was only 55 per cent; price competition had forced concessions of \$3 to \$5 a ton on sheets, strip and some other products, and profits, which had made a comparatively good

showing in the final quarter of 1935, turned sharply downward.

It was at this juncture that an innovation was introduced in the steel industry—open prices publicly announced. It is true that open prices were in effect under the NRA Steel Code, but when the code was discarded along with the rest of the NRA the steel industry was right back where it started from in the matter of preventing demoralization of prices through excessive competition, and all that had been preserved was the wider knowledge that had been gained from a scientific analysis under the code regime of prices, extras, allowances, freight rates, basing points and the other factors that go to make up the rather complicated steel price structure.

The move toward open prices was initiated by T. M. Girdler, chairman and president of Republic Steel Corp., who, in making an announcement of Republic's second

PIG iron production  
(daily average) compared with merchant  
iron output



quarter prices stated that "The new method of issuing prices has been adopted by Republic in the expectation that it would lead to elimination of unfair trade practices which have grown up in the steel industry. These unfair practices have included secret concessions, discriminatory prices as between customers, rebates and other methods harmful alike to producer and consumer. The steel industry has become notorious for such practices and for its inability to earn a fair profit. By eliminating these practices and adopting, for the first time in its history, a sound merchandising policy, the steel industry could make a great contribution to general recovery."

Thus was initiated the most successful price stabilizing movement the steel industry has experienced, other than the Steel Code. During the remainder of the year most of the steel companies followed Republic's example and made public announcement of their selling prices, with the result that the last three quarters of 1936 were remarkably free from price cutting, either open or secret, the general understanding between steel companies and their customers being that any change in published prices would be similarly announced. Some support for this price policy was received from the Robinson-Patman Price Discrimination Act, which, though confusing to many, seemed, at least in the opinion of most lawyers, to be aimed at some of the practices the steel industry had long indulged in.

The new price policy of Republic Steel Corp. was announced on March 10. To what extent the price stabilization that followed contributed to recovery in the steel industry may be open to argument, but it appears to be more than a coincidence that steel production turned sharply upward in April, and, in fact recovered somewhat in March from January-February levels that were lower than the November-December (1935) average, when prices were fairly stable. This is only one of the many instances in steel trade history that could be cited to establish the point always contended by the steel industry itself, but frequently disputed by economists and business analysts, that a lowering of steel prices (except in its long-range implications) does not contribute to business volume, but on the con-

trary usually acts as a deterrent to buying because weak prices destroy the confidence that is essential to a sound steel business. So far as steel is concerned, the right answer to this moot question probably is that business volume expands on rising prices up to the point where prices become excessive in the minds of buyers.

While the steel industry has contributed a great deal to its own prosperity and possibly to the prosperity of the country as a whole by the exercise of self-restraint in the matter of price competition, its practices in some respects have not met with the approval of one

branch of the Federal Government, namely that represented by Secretary of the Interior and PWA Administrator Harold L. Ickes, who filed complaints of collusive bidding on sheet steel piling, alleging violation of the anti-trust laws. This issue may have been disposed of only recently in the statement by John Dickinson, Assistant Attorney General of the United States, that "the anti-trust laws do not outlaw business practices and price policies merely because such policies may operate to make prices relatively rigid or to discourage price wars and market breaks."

## Buying Waves Precede Price Advances

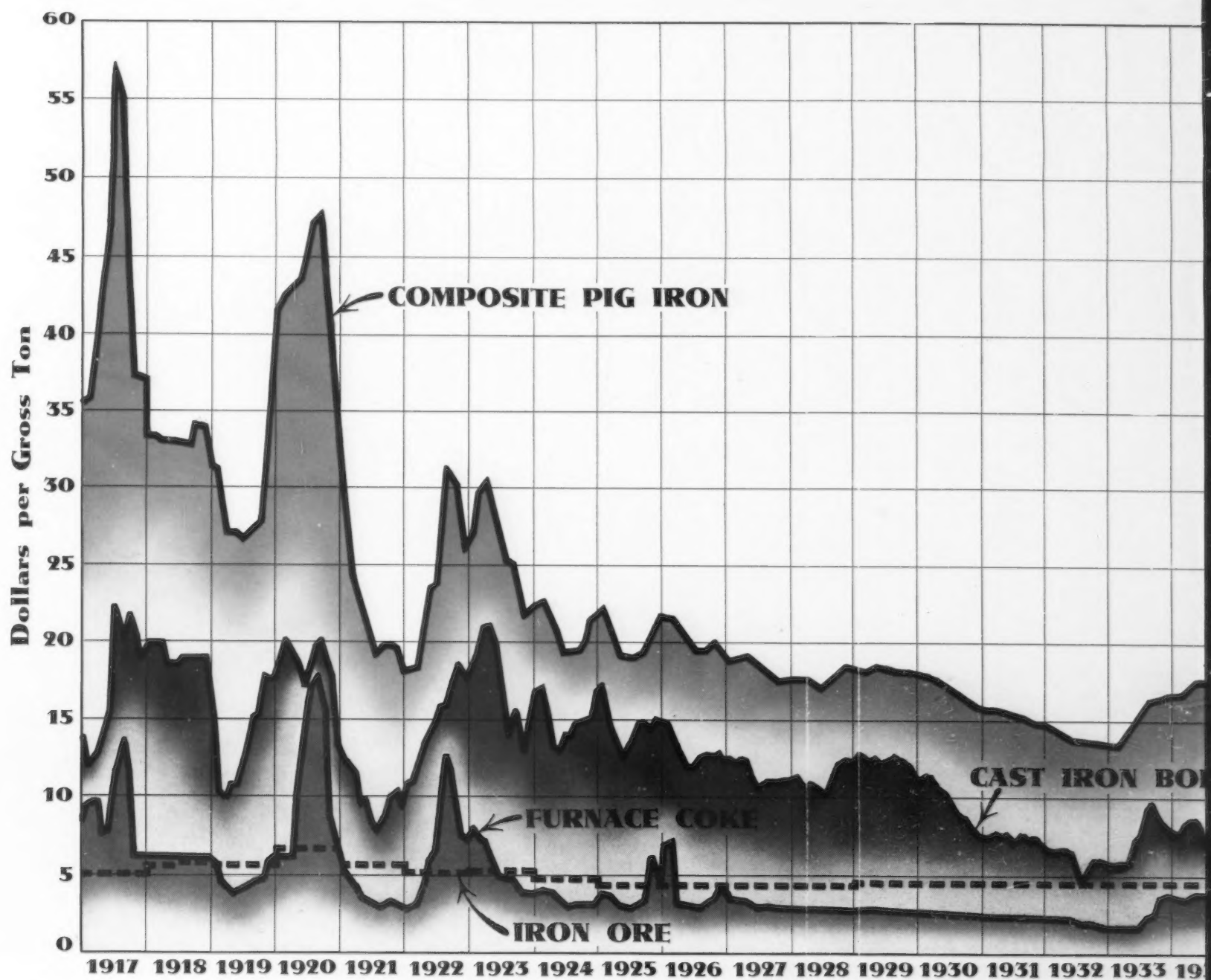
**F**OLLOWING a practice that had grown up under the Steel Code, the steel companies, with only one or two minor exceptions, announced prices for quarterly periods. There were some price advances in each quarter, and in each instance they were preceded by a wave of buying, the first of magnitude having occurred in June, putting enough business on mill books, plus that normally to be expected, to keep steel production on a higher basis during July and August than is usual for midsummer. Developments of July and August brought the realization that the June bulge had not been merely protective buying, but that business was farther along in the recovery cycle than had been generally realized. The real avalanche of buying occurred, however, when widespread price advances were announced for the fourth quarter, and that event is of such recent occurrence as to require no extended comment. It placed on mill books an unprecedented volume of business that carried production to the year's peak in the final month, when normally the trend is downward. This general price advance may not have created business, but it hastened into the market many projects that might ordinarily have been delayed into 1937.

At the year-end finished steel prices, as averaged in THE IRON AGE composite price, were 2.330c. a lb., which compares with the 1929 peak of 2.317c. and the depression low of 1.867c. in April, 1933. As compared with the 1929 peak, bars, plates and shapes are

currently \$4 a ton higher, plain wire, \$2 a ton higher, hot rolled annealed sheets, \$1 a ton lower, rails \$4 lower and pipe \$9 lower. It should be borne in mind, however, that 1929 prices at their peak, as reflected by our composite price, were only 62c. a ton above the 1928 peak and were \$1.70 a ton below the peak of 1927. As compared with 1929, new factors of costs have entered into the steel situation, namely wages 19 per cent higher than were paid steel mill workers in 1929, vacations to workers with pay, higher taxes and the cost of the Social Security Act, which went into effect Jan. 1. Not counting other new costs, steel mill wages have risen nearly 60 per cent since 1932, while steel prices have recovered only 40 per cent from their depression low.

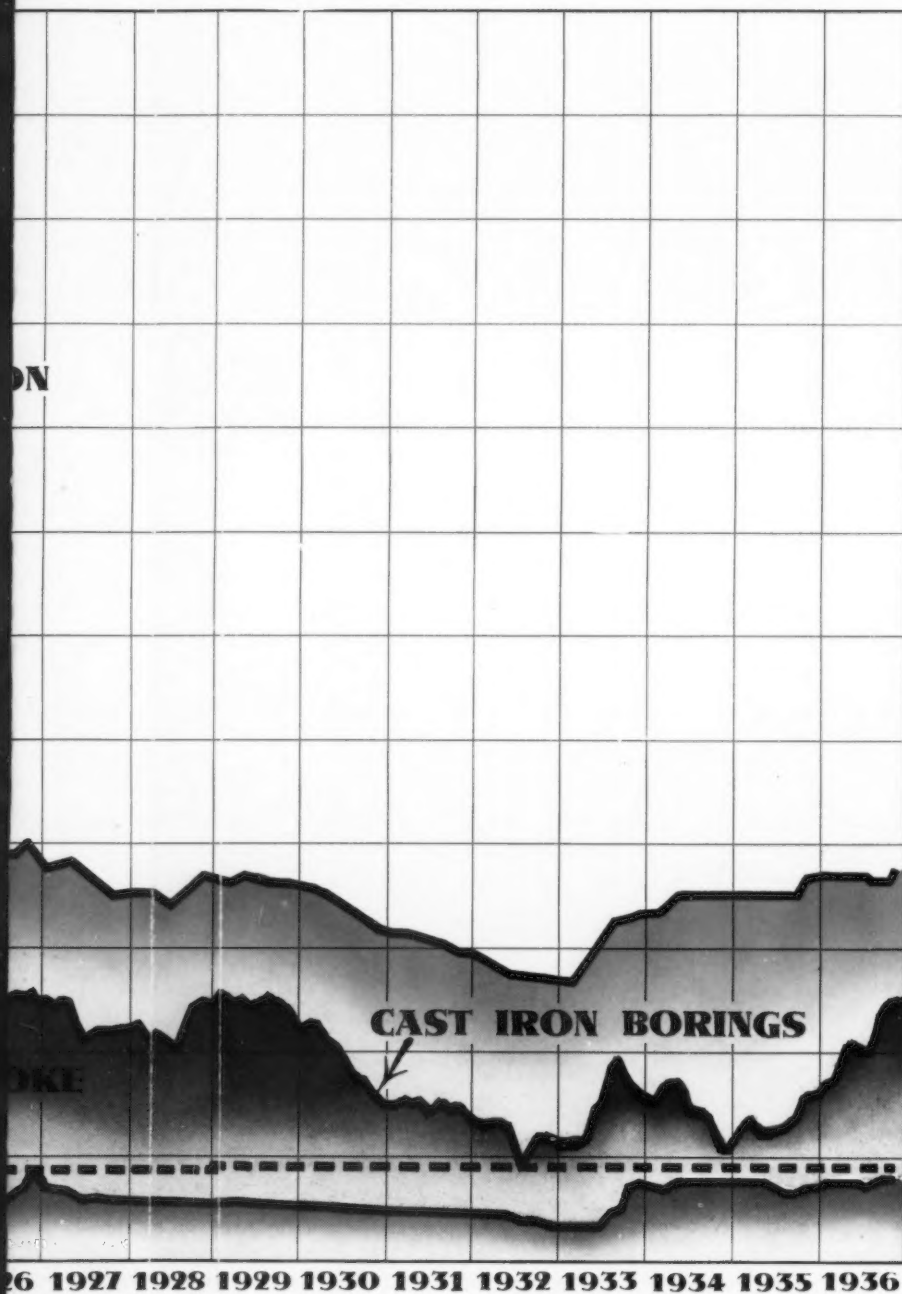
## Wage Increases Add to Costs

**W**AGES were increased generally throughout the steel industry on Nov. 16, averaging about 10 per cent and increasing the payroll of the industry approximately \$75,000,000 a year to an annual total of about \$936,000,000, according to the estimate of the American Iron and Steel Institute. The average hourly rate of wage earners in the industry is now about 73c. compared to 65.4c. in 1929. In addition to higher wages, vacations with pay were inaugurated by nearly all companies and the practice was established of paying time and a half for overtime for work over 8 hr. a day or 48 hr. a week. The number of employees in the



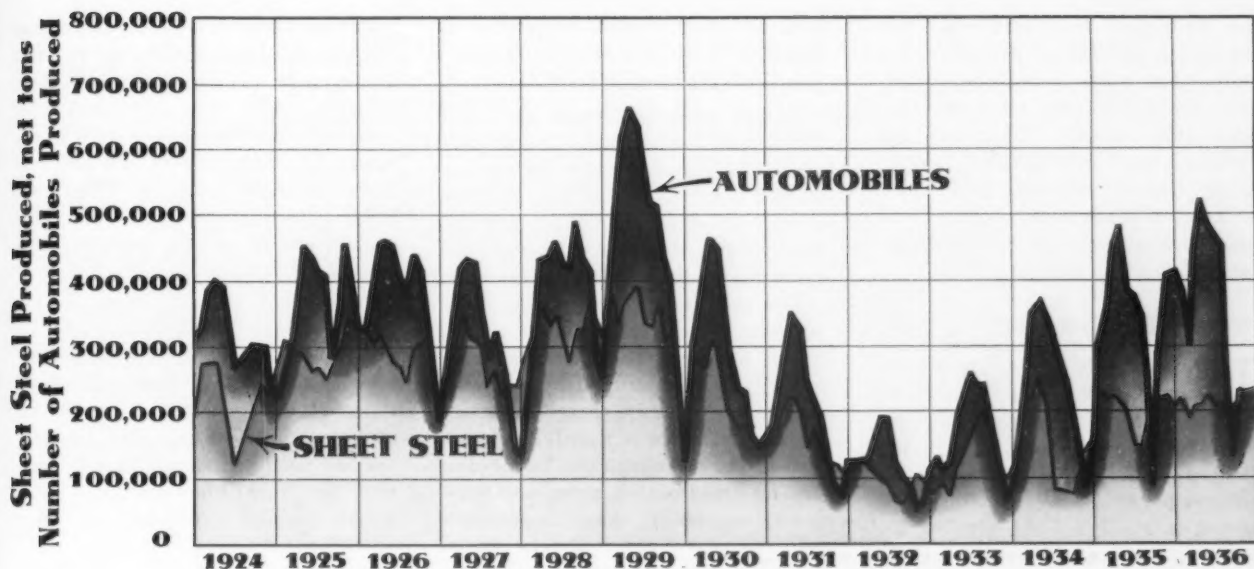
Pig iron prices have shown a sharp decline in the past year, but have no indication to increases in coke prices while the ore price remains

• • •



*Pig iron prices have shown strength during the past year, but have not risen in proportion to increases in coke and scrap prices, while the ore price remained stationary*

• • •



**THE relationship of automobile production to sheet steel production**

industry also increased materially, having reached a total of 531,000 in October against 454,000 at the beginning of the year and nearly 15 per cent over the number employed in 1929, reflecting to some extent the greater man-power required, despite extensive mechanization, to turn out the "tailor-made" steels that now form so prominent a part of finished steel output.

Although the steel industry greatly improved its earning capacity, having had net profits of

\$150,000,000 in 1936 against losses of that amount or more in the 1932 nadir of the depression, it earned no more than 3 per cent on its invested capital compared with 4.5 per cent in 1930 and 10.4 per cent in 1929. In other words, production was 87 per cent of that in 1929, but earnings were only 30 per cent as much.

additions and improvements in finishing mill facilities that increased such capacity, but the raw material branch of the industry remained in *status quo*, suffering meanwhile from the natural ravages of obsolescence. Thus the unexpectedly large demands of late 1936 found some companies short of coke ovens, blast furnaces and steel-making furnaces. In late summer the higher prices for scrap caused steel companies to resort to larger use of pig iron, and here is where the "bottlenecks" began to assert themselves. If there was sufficient blast furnace capacity, there wasn't enough coke capacity, or the capacity of furnaces was not great enough to supply the insatiable demands of larger finishing capacity. Steel companies that had been selling some of their by-product coke in the open market for domestic or industrial purposes were forced to curtail or eliminate such sales altogether in order to conserve supplies for their own metallurgical use and some would have been glad to buy coke in the open market; high cost blast furnaces were put into service (in one instance the work of scrapping an obsolete stack was stopped and it was put into blast); beehive coke ovens were rebuilt to supply the demand that by-product ovens could not completely satisfy; steel companies with various plants moved ingots and billets from one plant to another to balance their needs; raw steel was furnished to other departments where pressure

## Production Problems Multiply

WITH mounting demand and stabilized prices, the problems of the sales departments of steel companies were less than usual during a greater part of last year (except in the matter of satisfying customers on deliveries), but the production departments had special problems of their own, which were in part the outgrowth of the obsolescence and lack of new construction during the years of depression. In the few years following the 1929-1930 slump the steel industry had ample facilities for the small business that then existed, but by the middle of 1936 the increasing demands upon the mills had brought to light "bottlenecks" in the raw material branch of the industry, expansion of which had been neg-

lected in the years 1930-1933 and then was forbidden under the following resolution of the American Iron and Steel Institute, which was a part of the Steel Code:

"It is the consensus of the industry that, until such time as the demand for its products cannot adequately be met by the fullest possible use of existing capacities for producing pig iron and ingots, such capacities should not be increased. Accordingly, unless and until the Code shall have been amended as hereinafter provided so as to permit it, none of the members of the Code shall initiate the construction of any new blast furnaces or open hearth or bessemer steel capacity. . . ."

During the Code period, as well as before and after, there were

for deliveries was greatest, such as sheets and strip, and finishing mills that were considered ready for the scrap pile were pressed back into service. This was the cycle of problems that kept operating departments on their toes to meet the incessant demands of sales departments in fighting customers' battles for deliveries.

#### No New Blast Furnaces Since 1930

THE condition of pig iron producing capacity is illustrated by the fact that not a single new blast furnace has been built in the United States since 1930, when the International Harvester Co. completed a stack on the site of an old one at South Chicago. Only recently, however, the Inland Steel Co. announced plans for construction of a new furnace of 1000 tons daily capacity at its Indiana Harbor works, together with 59 coke ovens, the American Rolling Mill Co. decided to build a new furnace at Hamilton, Ohio, and the Republic Steel Corp. started the rebuilding of a furnace that when completed will have an enlarged capacity of 1000 tons a day. Owing to the great expense of new blast furnace construction, with the necessary complement of coke ovens, it is likely that the immediate trend will be toward modernization and enlargement rather than new furnaces, although that development is bound to come later if a high rate of steel production continues for some time.

During the period of nearly seven years in which no blast furnace construction took place, obsolescence was taking a larger toll than in any branch of the iron and steel industry. At the end of 1929 the total of potentially active blast furnaces was 316, according to records of the American Iron and Steel Institute and THE IRON AGE. Year by year a good many have been scrapped, with the result that THE IRON AGE list as of Dec. 31, 1936, shows only 250, of which four are charcoal. The 246 coke furnaces remaining on the list include several that have not been operated in years and may never be operated again unless unusually favorable market conditions and prices make short runs profitable. For example, furnaces that are either now being dismantled or will be in 1937, include one each for the Youngstown Sheet & Tube Co., and Gulf States Steel Co. and

two merchant stacks—Keystone of Reading Iron Co., and Vanderbilt No. 2 of Woodward Iron Co.

A few steel companies are still fairly well contained as to pig iron capacity, but the majority are so largely dependent upon a liberal supply of scrap that they are at the mercy of high scrap prices when all come into the market together in times of active steel production. While those steel companies that are short of pig iron capacity will be forced by circumstances to remedy their situation eventually, there is a different picture in the merchant pig iron field. One by one isolated merchant furnaces, especially those dependent upon purchased ore and coke, have been dropping by the wayside, leaving merchant pig iron business more and more to the steel companies, which are not so well able to take care of it in times like the present as they were when idle blast furnace capacity gave them a surplus for the market. Of the 246 potentially active furnaces, 201 are owned by steel companies, although not all are adjacent to steel plants, and 45 are independently owned merchant stacks. These latter include several that are devoted exclusively to specialties such as low phosphorus iron, silvery iron, ferromanganese and bessemer ferrosilicon, which cuts down the number that are or could be devoted to standard foundry or steel-making grades.

#### Coke Shortage Also a Factor

DESPITE greatly increased production of by-product coke and the resuscitation of the beehive coke industry, coke shortage was also a "bottleneck" in steel output. In 1935 the production of by-product coke was 34,224,053 tons and that of beehive was 917,208 tons. In 1936 by-product climbed probably to 42,000,000 to 43,000,000 tons, based on figures for the first 10 months and beehive output was about 1,500,000 tons. The supplementing of by-product coke with beehive coke has virtually reached its limit; while there were more than 13,000 beehive ovens still in existence at the end of 1935, many of these could not be put into service without expensive rebuilding. In the Connellsville field about 2500 are in service out of a possible 3000. As the demand for beehive coke is an emergency matter, there is little likelihood that the pro-

duction of this grade will approach its former importance—as recently as 1923 nearly 20,000,000 tons of this grade were produced. So long as blast furnace activity remains anywhere near its present level there will be no excess of coke, particularly not during the cold weather when heating demands must also be met.

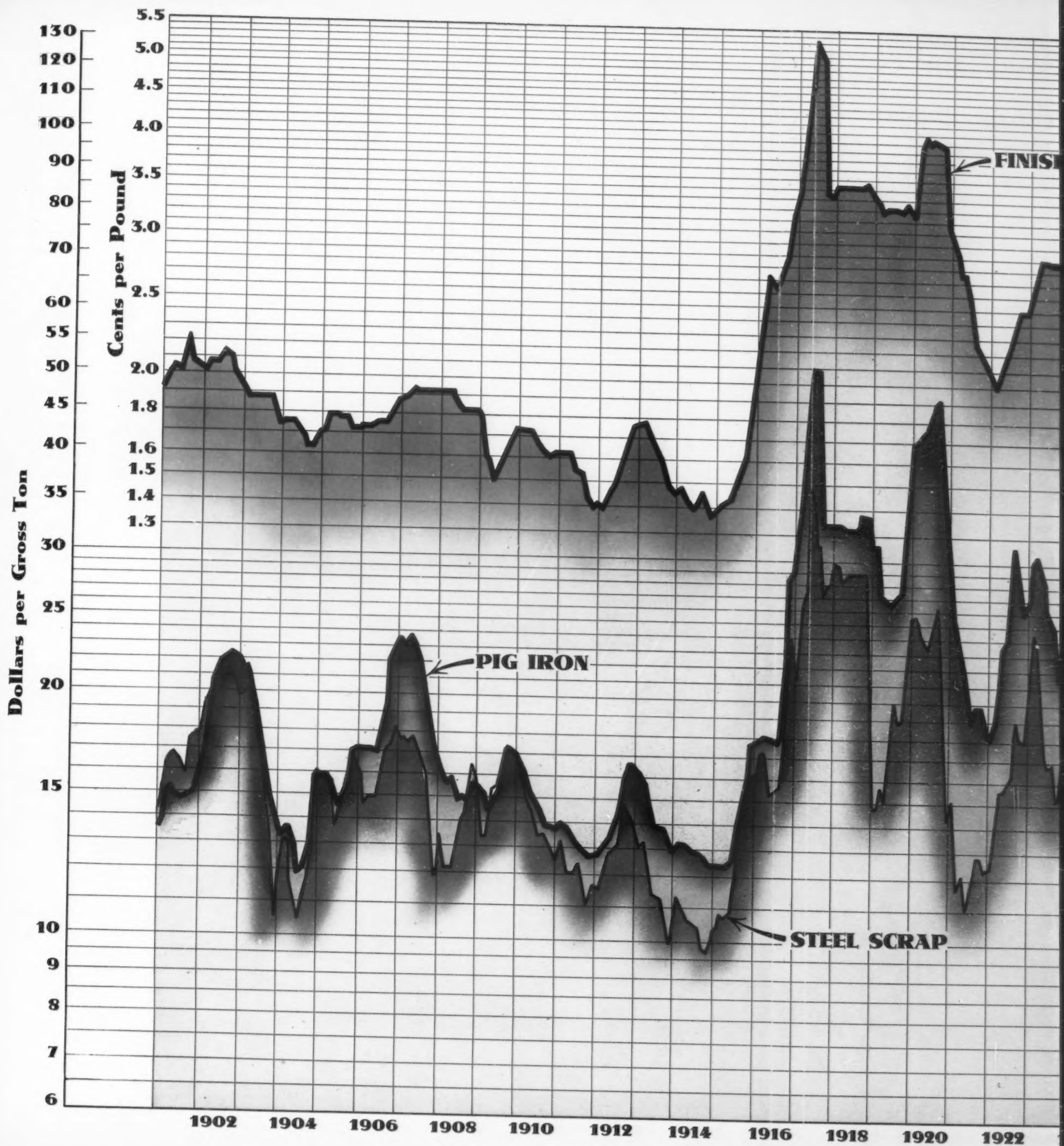
Ultimately these hindrances to effective steel production will be ironed out, some steps already having been taken in that direction. After the concentrated rush of business in November and December has been partially cleared from mill books within the next few weeks a more even demand may follow.

#### Continuous Sheet Mills Feature New Capacity Additions

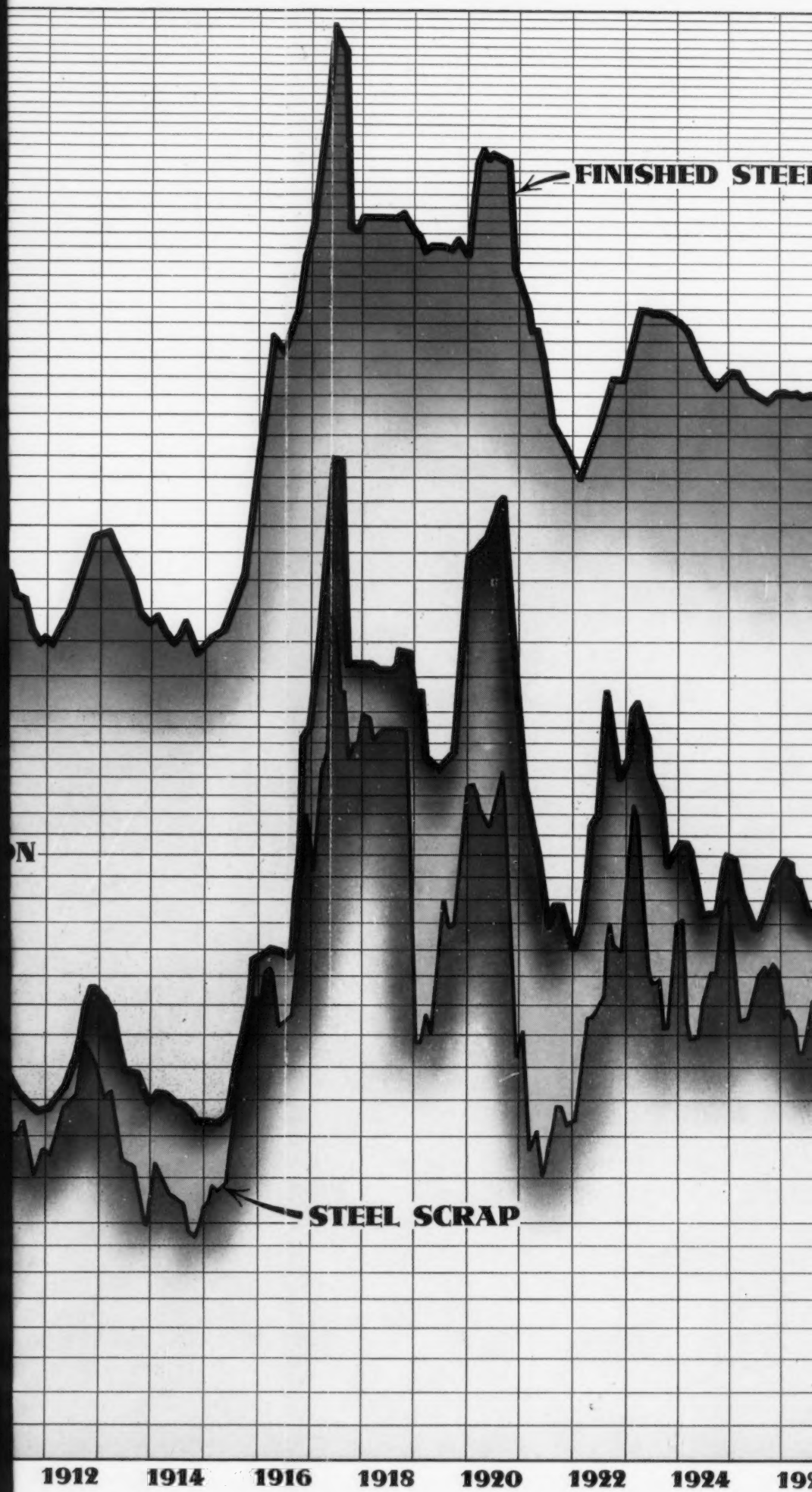
WHILE the outstanding additions to new capacity during 1936 were in the field of continuous sheet and strip mills, with cold reducing units for the higher grade sheets and cold reduced black plate for tinning, steel-making capacity was not neglected. Although some companies had enough steel-making capacity to provide for new continuous units, others were unbalanced in that respect and, as a consequence, added new furnaces. Eight new open-hearth furnaces were built, four by Inland Steel Co. and four by the Great Lakes plant (Detroit) of National Steel Corp. These furnaces increased the country's open-hearth capacity 788,000 tons annually, the first addition of this type since 1931. The growth of demand for alloy steels was shown by the installation of 38 electric furnaces and at least nine more are on order for delivery in 1937.

It is estimated that the industry spent fully \$200,000,000 in 1936, bringing the total outlay in 1935 and 1936 to \$340,000,000, according to an estimate of the American Iron and Steel Institute. Plans announced for 1937 represent a further outlay of \$175,000,000 to \$225,000,000, not counting some contemplated projects that are still in the blue print stage and have not been announced.

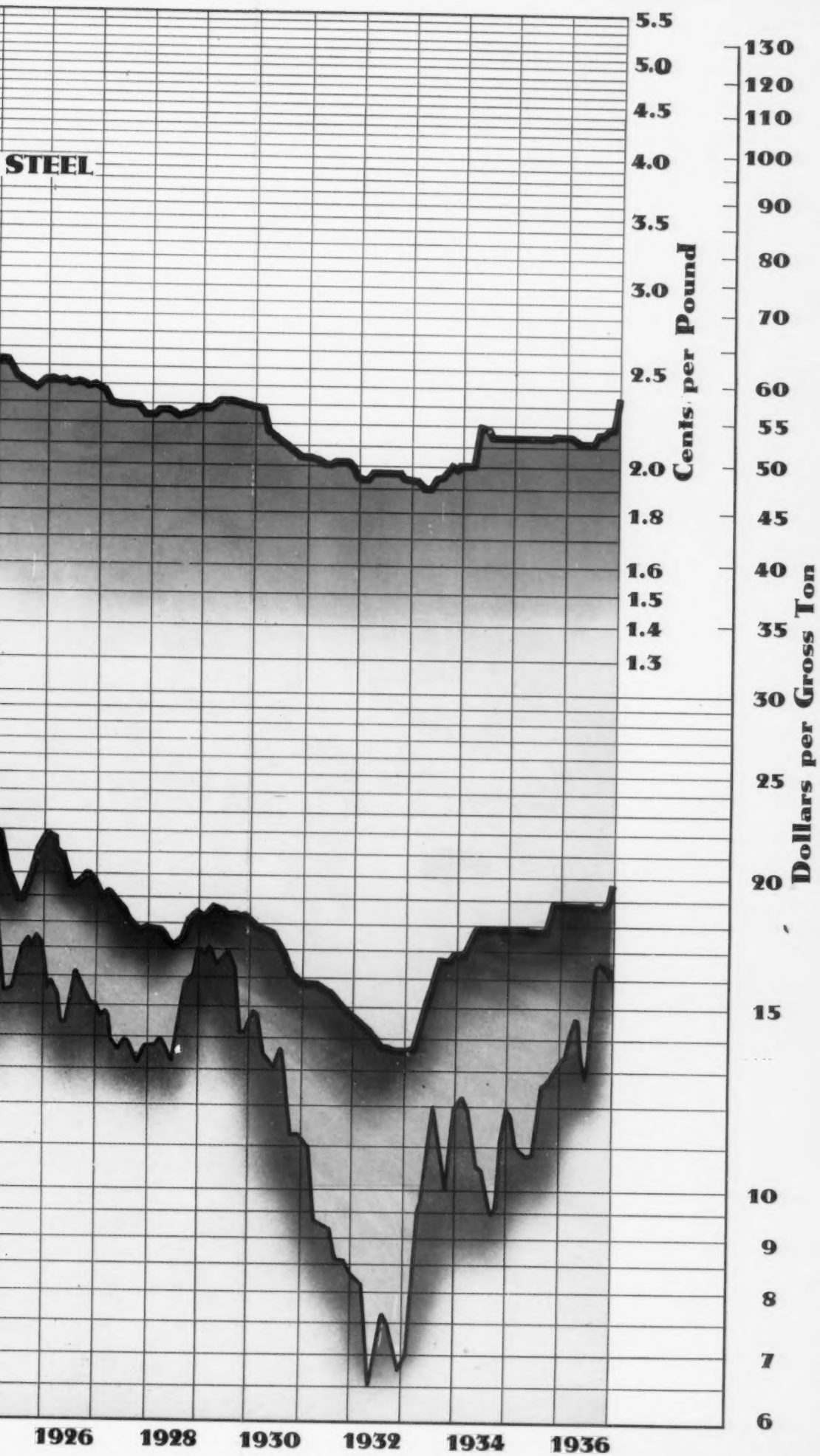
Outstanding in new construction were continuous sheet and strip mills. More flat-rolled steel capacity, of which the major portion was of the continuous mill type, was put into operation in 1936 than in any other year in the steel indus-



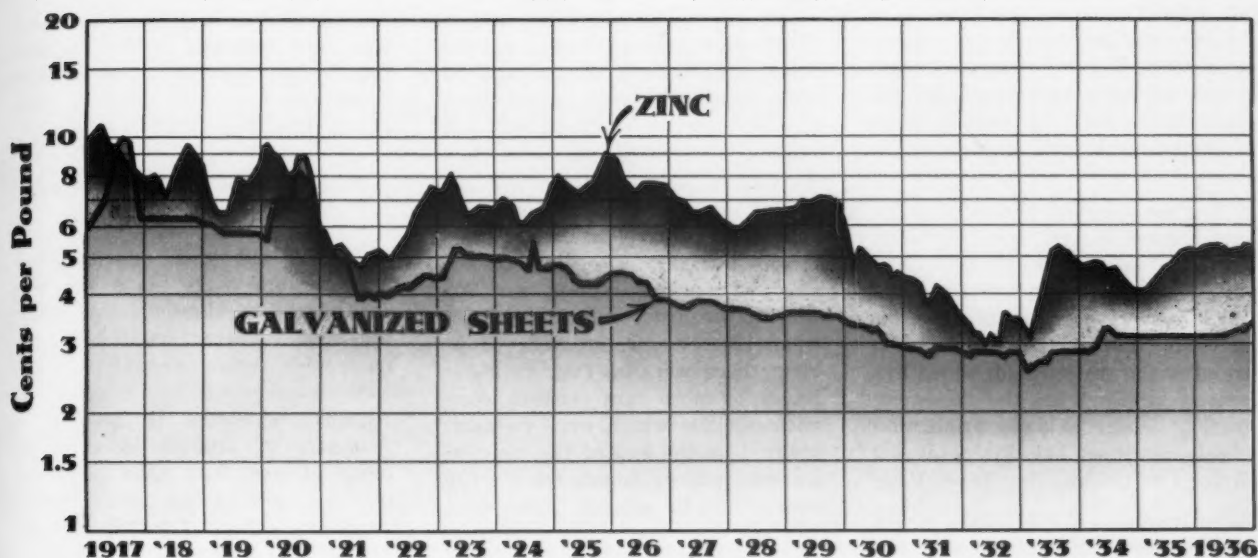
Price Curves of Finished Steel, Pig Iron and Steel Scrap



*Price Curves of Finished Steel, Pig Iron and Steel Scrap*







**THE trend of prices of  
galvanized sheets and  
zinc**

try's history. Hot rolling capacity totaled upward of 3,500,000 tons, which was complemented by well over 1,000,000 tons of cold rolling capacity. In addition, the new mills to be completed in 1937 will give about 1,600,000 tons more of hot mill capacity. Six continuous hot mills for sheets, strip and plates, six continuous cold mills and 10 or more single-stand cold mills were built last year; three continuous hot mills, and six continuous cold mills and at least five single-stand cold mills are definitely planned for 1937.

Of the \$200,000,000 expended in 1936, the larger steel companies accounted for a great portion. United States Steel Corp. added two wide strip and plate mills and three cold mills; Bethlehem Steel Co. built hot and cold continuous mills at Lackawanna, N. Y.; Jones & Laughlin Steel Corp. completed its 100-in. mill at Pittsburgh, and National Steel Corp. put in a continuous unit at its Great Lakes plant at Ecorse, Mich.

New construction in 1937 will call for the expenditure of about \$35,000,000 by Bethlehem Steel Co. at Sparrows Point, Md.; United States Steel Corp. will put in a new continuous mill at the Tennessee Coal, Iron & Railroad Co.'s plant at Birmingham at a cost of \$29,000,000; Republic Steel Corp. will spend \$20,000,000 for a 98-in. continuous mill with cold rolling units at Cleveland; Youngstown Sheet & Tube Co. has appropriated \$10,000,000 for a new cold rolling

mill and other improvements; Inland Steel Co. will spend several million dollars for a new blast furnace and coke ovens; American Rolling Mill Co. will build a new blast furnace at Hamilton, Ohio; Gulf States Steel Co. is to spend \$2,500,000, and Colorado Fuel & Iron Co., \$2,225,000.

Two important interests, Bethlehem Steel Co. and Jones & Laughlin Steel Corp., have put in continuous flat-rolling mills in order to balance their finishing capacity, which has been largely in the heavier products; the Jones & Laughlin company has never before made these products.

Other companies that were already engaged in a large way in sheet and strip manufacture were forced to provide facilities for the rolling of wider sheets to meet competition. The expanding demands for sheets and strip for many purposes, including the greater use by the automobile industry, constitute one of the most amazing phases of the steel industry's recovery and indicate the growing acceptance of steel in the lighter forms for a rapidly widening list of consumers' goods. The plain implication of this development is that the steel industry in future will not be obliged to depend so much, as in the past, on the

rising and falling requirements of the capital goods industries. Thus the curves of production may be leveled off to some extent.

#### Automobile Industry Again Leads the Recovery Movement

IN its use of steel for manufacturing, together with its large purchases of new shop equipment, the automobile industry was again leading the recovery, as it did in 1935, but it did not stand out almost alone as in that year because other major consuming lines took a long forward step, notably the railroads and building construction, although neither of these channels has approached in steel consumption its volume of the years preceding the depression.

Automobile production, meanwhile, has made full recovery to the number of vehicles produced in 1928. The 1936 production of cars and trucks in the United States and Canada is estimated at 4,600,000 against 4,182,191 in 1935, a gain of a little over 400,000 units, or less than 10 per cent against a 44 per cent increase in 1935 over the much lower 1934 output. The 1937 production is estimated by analysts of the industry at 5,200,000 to 5,300,000 units, but there will be a relatively higher volume of steel consumption than in 1936 because of more steel per car—possibly an average of about 65 lb. The Unisteel body adopted by Fisher Brothers (General Motors) will mean 35 per cent more steel, or a gain for General Motors alone

of 600,000 tons, on the basis of a 10 per cent increase in car output over 1936. Moreover, all-steel tops, which are now universal, call for more steel per car and uses of stainless steel trim have also increased.

The house trailer field also promises increased steel use. Probably 35,000 to 45,000 were built in 1936, and some optimists predict at least 100,000 this year. Increasing use of steel marks the construction trend in the trailer field, which has passed partly from the "one-man factory" stage to mass production plants, such as the Pierce-Arrow Motor Car Co. and the Hayes Body Co.

The automobile industry has aided prosperity in the machine tool and allied industries by large expenditures for shop equipment. General Motors spent \$80,000,000, Ford about \$40,000,000, Chrysler, \$10,000,000 and Packard, \$7,000,000, not counting the smaller units of the industry.

#### Building Construction Lagging

While building construction made substantial advances in 1936 to a total expenditure estimated at more than seven billion dollars, compared with around 12 billions in pre-depression peak years, it is still lagging behind other major outlets for steel in its approach to a normal volume, despite the extensive pump priming afforded by Government aid. However, for the first time in several years there are signs of an appreciable amount of private work, which may tend to expand in 1937. A big field lies in residential construction, some authorities estimating that the country is in need of six to seven million new dwellings. Therefore, under favorable conditions, the construction industry should offer much greater support to the steel industry and allied lines during the new year than in 1936. It is upon the building industry in particular that reliance is placed to bring up business as a whole to well balanced prosperity levels and to absorb some of the millions of workers still on relief.

#### Railroad Buying a Big Factor; Will Continue in 1937

**R**AILROADS will assuredly be more of an important factor in 1937 than in 1936 in the purchase of steel and shop equipment and

various types of new construction. While their purchases of cars, locomotives and rails at the end of 1936 were extremely heavy, much of the material required will appear in 1937 steel mill shipments. A considerable portion will be spread over the entire first half. The number of freight cars ordered up to Dec. 21, according to the *Railway Age* tabulations, was 54,750, the largest volume since 1929, when 124,140 were ordered. However, there were on Dec. 21 about 20,000 or more cars pending, commitments for which were virtually assured by the end of the year, so a conservative estimate for the full year would be around 75,000 cars. (Latest details on this appear in the regular market section of this issue.)

Locomotives ordered up to Dec. 21 were 478, the most in any year since 1930, when 555 were ordered. Passenger cars, exclusive of the new type streamlined, light-weight trains, totaled 213, highest since 1934, when 403 were ordered. Fifteen streamlined trains, with a total of 106 cars, were bought.

It may be that the bulk of new equipment purchases for the present were concluded at the end of 1936, but a vast amount of general repair work is scheduled. Two of the country's largest systems, New York Central and Pennsylvania, have already made plans that will keep their shops extremely busy for some time to come.

These three major steel consuming channels — automobile, construction and railroads—have in previous normal times accounted for about half or more than half of all of the finished steel produced. Added to these are greatly expanding uses for steel in widely diversified lines, which, if maintained at their recent peaks and supplemented by enlarged demand for automobiles, building and railroads, will, in 1937, assure the steel industry an outstanding year. It is not expected that the record-breaking tonnage of 1929 will be duplicated, but there will probably be a nearer approach to it than in 1936.

Long-term predictions as to steel tonnage are hazardous, particularly so now, because the state of world affairs and domestic labor troubles may create situations that can only be guessed at, but, barring

such eventualities as a European war or widespread strikes in this country, an ingot output of at least 50,000,000 tons in 1937 is a fair assumption.

#### Labor Troubles the More Serious Threat to Production

**A**S the old year ended, labor troubles were the most serious threat to steel production. While the steel industry itself has had no trouble serious enough to warrant expectation of the much-feared steel strike, it has had a foretaste of trouble in the sit-down strikes that have occurred in the plants of automobile parts suppliers, where John L. Lewis' Committee for Industrial Organization, through the automobile workers' unions, stopped work in a number of plants highly essential to automobile production.

These labor troubles have come as an aftermath of the most widespread wage advances within a short period in industrial history. And they were accompanied by additional bonus payments in many instances. In the main the wage advances were initiated by the steel industry, starting with the United States Steel Corp.

**A**BOUT the middle of the year John L. Lewis and his Committee for Industrial Organization laid plans to unionize the steel industry. As their organization vehicle, they picked out the Amalgamated Association of Iron, Steel and Tin Workers whose identity was immediately lost and replaced by the Steel Workers' Organizing Committee.

The methods used by the SWOC in its organization drive were far different from any used in the steel industry before. An elaborate and efficient headquarters was established in one of Pittsburgh's best office buildings and at least 200 high-pressure organizers were engaged. A semi-monthly labor paper was started, its pages devoted entirely to propaganda furthering the unionization of steel workers. Leaders of the SWOC have frequently taken to the air to broadcast their views; public address systems during intensive drives have been brought into play; and even the application cards given to prospective members need only to be dropped into the nearest mail box without the bother of buying

# Automotive Industry Far in the

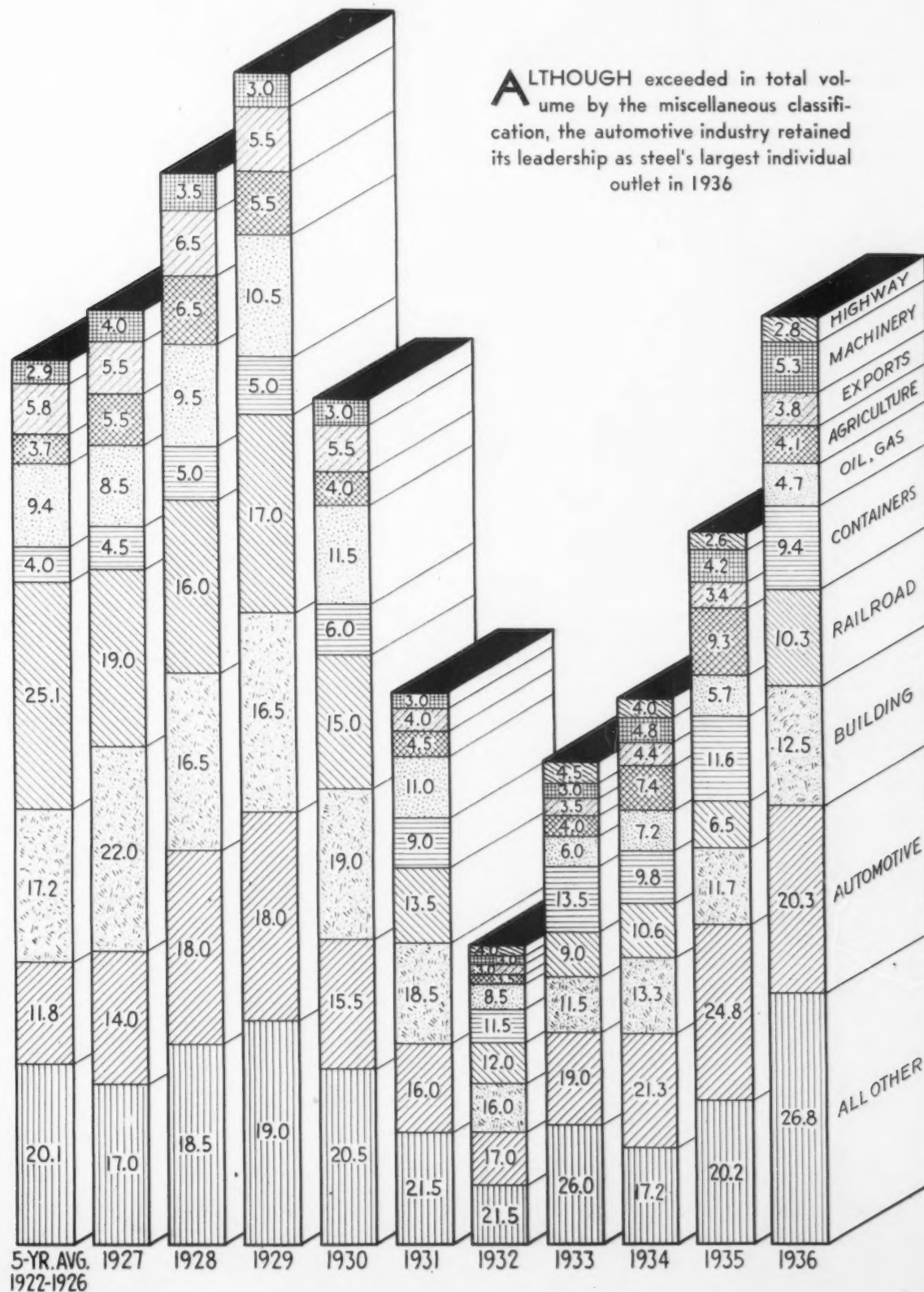
THE automotive industry in 1936 retained the commanding lead it has held for many years as the steel industry's chief consuming outlet notwithstanding the fact that other major consuming groups greatly enhanced their relative positions as compared with 1935. While the automotive group showed a smaller percentage of the finished steel total than in 1935, its aggregate consumption of steel increased quite sharply, though not to the extent (in percentage) that occurred in the railroad and construction classifications. Although gains were made all along the line, both

in the amount of steel taken by most classes of consumers and in the production of individual products, the outstanding development indicated by the figures is the rise in capital goods classifications. This is shown in figures for such products as rails and track accessories, plates, structural shapes and pipe, while at the same time those products generally associated with consumer goods, such as sheets, strip, wire and tin plate, also made major gains.

In estimating the total production of finished steel in 1936 it has not been necessary in this survey by THE IRON

AGE to make many additions to the figures supplied by the steel companies in view of the fact that 51 companies having a total ingot producing capacity of 94.3 per cent of the ingot capacity of the country submitted returns. And, in addition, all but a few of the companies that roll finished steel but do not produce their own ingots supplemented the figures from the integrated companies with their own shipments of various products. The total 1936 output of finished steel is estimated at 32,000,000 gross tons, against which the figures tabulated on this page show an actual total

from companies reporting 600 tons. It should be in this connection that wire rods were placed in the wire rod category and that skelp from other mills for further conversion was placed in the pipe column, but billets and shears were shipped for further processing were not included in the tabulation for the reason that nearly all non-integrated companies that purchase of semi-finished steel report finished steel shipments. It appears from the figures



DISTRIBUTION OF ROLLED STEEL IN 1936 ACCORDING TO INDUSTRY

INDUSTRY	Rails	Total
1. Railroads:		
(a) Cars and locomotives	4.9	
(b) Buildings and bridges	1,066.7	
(c) Rails and accessories		
2. Construction:		
(a) Fabricators and contractors	0.3	
(b) Building trim manufacturers	0.1	
3. Auto and parts makers	0.1	
4. Oil, gas and water	0.1	
5. Mining, lumbering and quarrying	27.9	
6. Agriculture:		
(a) Implements and tractors	0.1	
(b) Other farm uses		
7. Containers:		
(a) Tin cans	0.1	
(b) Tanks, barrels, drums, buckets, etc.	0.1	
8. Ship and barge builders	0.1	
9. Machinery and tools	1.4	
10. Electrical Manufacturers:		
(a) Motors and apparatus		
(b) Domestic appliances, including refrigerators		
11. Non-electrical household equipment		
12. Furniture and office equipment		
13. Highways and highway bridges		
14. Belt, nut and rivet makers		
15. Jobbers and warehouses	11.3	
16. Exports	26.5	
17. Unclassified	17.4	
Total	1,157.0	

\*Includes coated plate

ESTIMATED TOTAL PRODUCTION OF ROLLED STEEL IN 1936

	Five-Year Average 1922 to 1926		1927
	M. Tons	Per Cent	M. Tons
Buildings.....	5,250	17.2	7,100
Railroads.....	7,680	25.1	6,100
Automotive.....	3,600	11.8	4,500
Oil, gas and mining.....	1,860	9.4	2,750
Metal containers.....	1,230	4.0	1,450
Agriculture.....	1,134	3.7	1,800
Shipbuilding.....			
Machinery.....	*892	2.9	1,300
Exports.....	1,760	5.8	1,800
Highways.....			
Miscellaneous.....	6,130	20.1	5,500
Total.....	30,530		32,300

\*Four-year average.

ESTIMATED TOTAL PRODUCTION OF ROLLED STEEL IN 1936

	Five-Year Average 1922 to 1926		1927
	M. Tons	Per Cent	M. Tons
Rails	2,703	8.9	2,806
Plates	3,735	12.2	3,718
Black plate for tinning	1,515	5.0	1,657
Other sheets	3,902	12.8	4,245
Strips	244	0.8	1,318
Wire rods	2,763	9.1	2,770
Shapes	3,385	11.1	3,742
Bars, merchant	4,684	15.3	4,682
Bars, concrete	709	2.3	814
Pipe, skelp and tube rounds†	3,158	10.3	4,152
Hoops, bands, cotton ties*	527	1.7	499
Track accessories	716	2.3	828
Other finished products	2,507	8.2	1,103
Total	30,546		32,334

\*Included in strips

†Tube rounds included since 1925.

# Industry Far in the Lead in Finished Steel Consumed in

additions to the steel com-  
fact that 51 com-  
ingot producing  
cent of the ingot  
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ion, all but a few  
roll finished steel  
their own ingots  
ures from the in-  
with their own  
s products. The  
finished steel is  
000 gross tons,  
figures tabulated  
an actual total

from companies reporting of 29,622,-  
600 tons. It should be explained in  
this connection that wire rods shipped  
to mills for further conversion have  
been placed in the wire products  
category and that skelp shipped to  
other mills for further conversion has  
been placed in the pipe and tubing  
column, but billets and sheet bars that  
were shipped for further conversion  
were not included in the table for the  
reason that nearly all non-integrated  
companies that purchase such forms  
of semi-finished steel reported their  
finished steel shipments.

It appears from the figures that the

automotive industry took about 6,500,-  
000 tons of finished steel in 1936, the  
railroads 3,300,000 tons, construction  
4,000,000 tons and metal containers  
3,000,000 tons. These were the out-  
standing consuming outlets. Use of  
steel by the railroads for cars and  
locomotives and for rails and accesso-  
ries rose sharply over the preceding  
year, but the amount taken by them  
for buildings and bridges increased  
only moderately. However, some ton-  
nage for building work was undoubt-  
edly taken by the railroads from  
stocks of fabricators and jobbers, and  
this would not necessarily show up in

the figures compiled by the steel com-  
panies except in the fabricator and  
jobber classifications. The agricul-  
tural classifications are considerably  
lower both in percentage and in total  
tonnage than in 1935, a probable indi-  
cation of the effect of last summer's  
drought.

Metal containers rose in steel con-  
sumption, but declined in percentage  
of total steel shipped. Black plate for  
tinning, including coated plate, gained  
a few hundred thousand tons, and the  
gain may possibly be accounted for,  
in part at least, by growing use of cans  
for beer and in so-called general lines.

## DISTRIBUTION OF ROLLED STEEL IN 1936 ACCORDING TO SHIPMENTS OF COMPANIES HAVING 94.3 PER CENT OF THE TOTAL INGOT PRODUCTION

Amount of Each Form (In Thousands of Gross Tons) Taken by Different Industries

INDUSTRY	Rails	Track Accessories	Shapes	Plates	Bars	Concrete Bars	*Black Plate for Tinning	Galvanized Sheets	All Other Sheets	Strip Steel	Pipe and Tubing	Wire Products
Railroads:												
Cars and locomotives.....		10.9	180.8	424.5	180.5		0.2	26.5	112.2	42.7	79.8	22.2
Buildings and bridges.....	4.9	1.2	135.0	41.2	21.6	6.5	0.1	3.9	39.6	4.6	0.3	12.2
Rails and accessories.....	1,066.7	457.4	0.3	10.0	17.2	1.0			0.2	0.4	0.1	6.6
Construction:												
Fabricators and contractors.....	0.3		1,198.1	288.3	137.4	416.1	1.1	35.6	65.8	24.1	17.5	122.2
Building trim manufacturers.....	0.1		24.1	19.1	43.0	0.4	1.2	45.5	57.7	40.5	2.5	59.2
Auto and parts makers.....	0.1		16.7	74.6	1,340.4	0.5	7.1	10.9	2,134.3	1,648.6	90.9	118.2
Gas and water.....	0.1	0.6	36.9	141.9	11.0	6.5	37.9	2.5	80.5	0.9	816.3	6.6
Logging, lumbering and quarrying.....	27.9	13.9	13.7	16.7	11.3	2.8		2.6	7.3	3.4	2.4	7.7
Agriculture:												
Implement and tractor.....	0.1		25.6	24.8	236.0	0.3		22.2	61.0	57.0	14.3	8.8
Other farm uses.....			0.1	0.2	1.1	2.2	0.1	15.0	14.3	12.7	0.1	224.2
Containers:												
Tin cans.....							1,773.9		34.1	0.4		1.1
Tanks, barrels, drums, buckets, etc.....	0.1		39.4	324.9	21.9		47.9	29.2	341.4	96.6	17.8	33.2
Ship and barge builders.....	0.1	0.1	31.8	142.1	12.8	0.1		1.2	3.3	0.8	19.4	2.2
Machinery and tools.....	1.4	0.1	78.1	106.0	230.6	1.2	1.3	5.2	46.9	28.2	32.7	24.2
Electrical Manufacturers:												
Motors and apparatus.....			26.5	40.7	67.2	7.3	0.6	3.4	205.3	57.1	52.1	34.2
Domestic appliances, including refrigerators.....								9.0	141.7	38.4		
Non-electrical household equipment.....			1.2	0.6	16.1		11.5	10.5	210.9	13.7	0.6	7.7
Furniture and office equipment.....			2.0	1.3	19.1			25.6	221.4	84.7	5.3	105.2
Roadways and highway bridges.....			139.7	11.7	5.7	89.2		87.4	16.0	1.4	0.1	41.1
Nut and rivet makers.....				0.3	227.1				2.9	4.1	1.4	123.2
Shops and warehouses.....	11.3	12.3	267.2	170.7	297.9	171.9	25.8	572.7	349.0	105.6	765.3	660.2
Ports.....	26.5	8.4	74.4	115.5	41.3	21.0	283.0	68.5	131.5	55.5	48.6	154.2
Unclassified.....	17.4	11.6	82.7	397.1	957.9	30.1	55.6	212.3	1,171.7	532.6	978.5	939.2
Total.....	1,157.0	516.5	2,374.3	2,352.2	3,897.1	757.1	2,250.7	1,189.7	5,449.0	2,854.0	2,946.0	2,717.2

\*Includes coated plate

## ESTIMATED TOTAL DISTRIBUTION OF FINISHED STEEL (THOUSANDS OF GROSS TONS)

	Five-Year Average 1922 to 1926		1927		1928		1929		1930		1931		1932		1933		1934	
	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent
Automotive.....	5,250	17.2	7,100	22.0	6,100	16.5	6,700	16.5	5,500	19.0	3,500	18.5	1,650	16.0	1,900	11.5	2,500	13.3
Buildings.....	7,680	25.1	6,100	19.0	6,000	16.0	6,900	17.0	4,400	15.0	2,550	13.5	1,250	12.0	1,500	9.0	2,000	10.6
Construction.....	3,600	11.8	4,500	14.0	6,700	18.0	7,300	18.0	4,500	15.5	3,050	16.0	1,750	17.0	3,150	19.0	4,000	21.3
Gas and mining.....	1,860	9.4	2,750	8.5	3,500	9.5	4,300	10.5	3,350	11.5	2,100	11.0	900	8.5	1,000	6.0	1,350	7.2
Containers.....	1,230	4.0	1,450	4.5	1,850	5.0	2,000	5.0	1,750	6.0	1,700	9.0	1,200	11.5	2,250	13.5	1,850	9.8
Agriculture.....	1,134	3.7	1,800	5.5	2,400	6.5	2,250	5.5	1,150	4.0	850	4.5	350	3.5	650	4.0	1,382	7.4
Building.....													100	1.0	175	1.0	300	1.6
Machinery.....	*892	2.9	1,300	4.0	1,300	3.5	1,200	3.0	900	3.0	600	3.0	300	3.0	500	3.0	900	4.8
Shops.....	1,760	5.8	1,800	5.5	2,400	6.5	2,250	5.5	1,600	5.5	750	4.0	300	3.0	550	3.5	835	4.4
Warehouses.....													400	4.0	750	4.5	750	4.0
Unclassified.....	6,130	20.1	5,500	17.0	6,900	18.5	7,700	19.0	6,000	20.5	3,900	20.5	2,100	20.5	4,175	25.0	2,940	15.6
Total.....	30,530		32,300		37,150		40,600		29,150		19,000		10,300		16,600		18,807	

\*Four-year average.

## ESTIMATED TOTAL PRODUCTION OF FINISHED STEEL (THOUSANDS OF GROSS TONS)

	Five-Year Average 1922 to 1926		1927		1928		1929		1930		1931		1932		1933		1934	
	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent	M. Tons	Per Cent
Automotive.....	2,703	8.9	2,806	8.7	2,647	7.1	2,722	6.7	1,873	6.4	1,158	6.1	403	3.9	416	2.5	1,010	5.4
Buildings.....	3,735	12.2	3,718	11.5	3,912	10.5	5,018	12.4	3,662	12.6	1,965	10.4	830	8.0	1,160	7.0	1,438	7.6
Construction.....	1,515	5.0	1,657	5.1	1,792	4.8	1,699	4.2	1,692	5.8	1,431	7.5	1,000	9.7	1,964	11.8	1,735	9.1
Gas and mining.....	3,902	12.8	4,245	13.1	5,296	14.2	5,716	14.1	3,713	12.8	2,642	13.9	1,613	15.6	3,084	18.6	3,193	17.0
Containers.....	244	0.8	1,318	4.1	2,161	5.8	2,503	6.2	1,941	6.7	1,620	8.5	1,185	11.4	1,929	11.6	2,273	12.1
Agriculture.....	2,763	9.1	2,770	8.5	3,080	8.3	3,134	7.7	2,347	8.0	1,844	9.7	1,186	11.4	2,024	12.2	1,723	9.2
Building.....	3,385	11.1	3,742	11.6	4,096	11.1	4,778	11.8	3,512	12.0	2,063	10.9	937	9.0	1,109	6.7	1,425	7.6
Machinery.....	4,684	15.3	4,682	14.5	6,113	16.4	6,306	15.5	4,043	13.8	2,391	12.6	1,285	12.4	2,245	13.5	2,711	14.4
Shops.....	709	2.3	814	2.5	951	2.6	952	2.3	850	2.9	644	3.4	385	3.7	369	2.2	487	2.6
Warehouses.....	3,158	10.3	4,152	12.9	4,420	11.9	4,798	11.7	3,816	13.1	2,162	11.4	946	9.3	1,548	9.3	1,896	10.1
Unclassified.....	527	1.7	499	1.5	559	1.5	586	1.4	126	0.4	113	0.6	80	0.8	*	*	*	*
Accessories.....	716	2.3	828	2.6	750	2.0	889	2.2	590	2.0	385	2.0	147	1.4	200	1.2	350	1.9
Finished products.....	2,507	8.2	1,103	3.4	1,400	3.8	1,532	3.8	1,032	3.5	569	3.0	355	3.4	557	3.4	566	3.0
Total.....	30,546		32,334		37,177		40,633		29,197		18,987		10,352		16,605		18,807	

Included in strips  
Tube rounds included since 1925.

in 1936

Compiled By  
N. E. MACMILLAN

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A change has been made in the table on distribution of rolled steel in that the figures published a year ago as "undistributed according to consumers" have been included in the "unclassified" totals. The aggregate of such unclassified tonnage is 8,300,000 tons, or 25.9 per cent of all finished steel. Included in this figure is a fairly substantial amount in such classifications as pressed and formed metal manufacturing and forging. There is also the fact that some companies report their shipments by products, but do not classify them by consuming industries, thereby leaving no alterna-

tive but to include them in the unclassified figures.

Like carbon steels, the production of alloy steel ingots and castings in 1936 underwent a tremendous pickup, the estimated figure for the year being 3,210,000 gross tons, representing a 51 per cent increase over production in 1935. This tonnage figure includes all corrosion-resisting and heat-resisting castings and ingots and all general alloy ingots containing more than 0.40 per cent nickel, 0.30 chromium, 0.50 copper, 1.65 manganese, 0.50 silicon, 0.10 molybdenum and any percentage of vanadium, tung-

sten, cobalt, titanium and zirconium.

Of the 3,210,000 tons of alloy ingots and castings poured in 1936, about 68 per cent was converted into finished steel for use by the automotive trade, railroads accounted for approximately 2.9 per cent, agriculture took 4 per cent, slightly over 5 per cent went into machinery, almost 1 per cent went into construction, about 0.7 per cent was used by shipbuilders, almost 3 per cent went into the petroleum industry, household equipment took 1.2 per cent, exports accounted for over 1 per cent and the remainder went into various miscellaneous outlets.

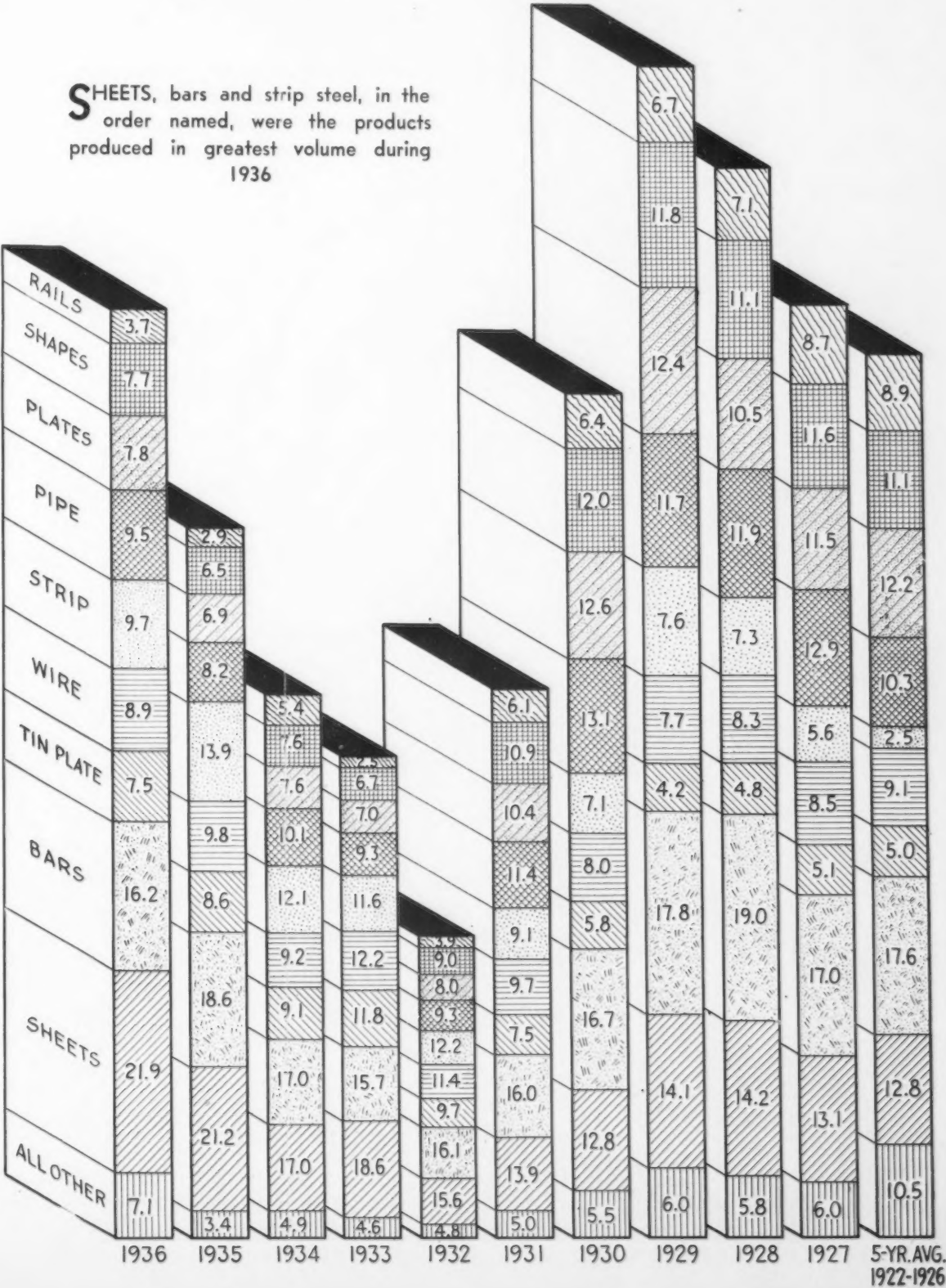
INGOT PRODUCING CAPACITY

	Wire Products	All Other Finished Steel	Total All Finished
8	22.0	244.5	1,324.6
3	12.9	2.5	274.3
1	6.9	15.8	1,576.0
5	122.6	29.5	2,336.4
5	59.3	14.4	307.8
9	118.6	104.0	5,546.7
3	6.9	12.4	1,154.4
4	7.3	11.4	120.7
3	8.5	4.4	454.2
1	224.1	1.3	271.2
8	1.4	1.2	1,811.0
4	33.5	1.6	954.3
7	2.1	25.2	239.0
	24.8	32.2	588.7
1	34.6	14.7	509.5
6	7.0	0.2	189.3
3	105.5	8.1	476.4
1	41.8	7.1	400.1
4	123.9	9.3	369.0
3	660.3	58.3	3,468.3
6	154.0	44.1	1,072.3
5	939.8	507.4	5,894.7
0	2,717.8	1,161.2	29,622.6

1934	1935	1936
Per Cent	M. Tons	Per Cent
13.3	2,865	11.7
10.6	1,605	6.5
21.3	6,075	24.8
7.2	1,400	5.7
9.8	2,840	11.6
7.4	2,270	9.3
1.6	215	0.9
4.8	1,040	4.2
4.4	825	3.4
4.0	650	2.6
15.6	4,720	19.3
	24,505	32,000

1934	1935	1936
Per Cent	M. Tons	Per Cent
5.4	700	2.9
7.6	1,700	6.9
9.1	2,100	8.6
17.0	5,200	21.2
12.1	3,400	13.9
9.2	2,400	9.8
7.6	1,600	6.5
14.4	4,075	16.6
2.6	500	2.0
10.1	2,000	8.2
	325	1.3
	505	2.1
	24,505	32,000

**S**HEETS, bars and strip steel, in the order named, were the products produced in greatest volume during 1936





stamps. In other words, the SWOC has adopted the most up-to-date and efficient business methods in its organization drive.

At the beginning of the drive, not much progress was made, but with the postponing of dues-paying and several "lucky breaks" because of labor unrest preceding the granting of wage increases, the outside unions have gained more adherents than is commonly supposed.

Facts coming to light at present time indicate that John L. Lewis is attempting to further the drive to unionize the steel workers by concentrating on those industries which depend heavily on the steel industry, the most outstanding one of which is the automobile industry. The latter has been harassed by labor troubles both in its own plants and in those supplying it with raw material, such as the Pittsburgh Plate Glass Co. and the Libbey-Owens-Ford Plate Glass Co., both of which furnish close to 85 or 90 per cent of the safety glass used in motor car manufacture. All of these events tied directly in with the general

plan of the CIO to organize the country's largest industry.

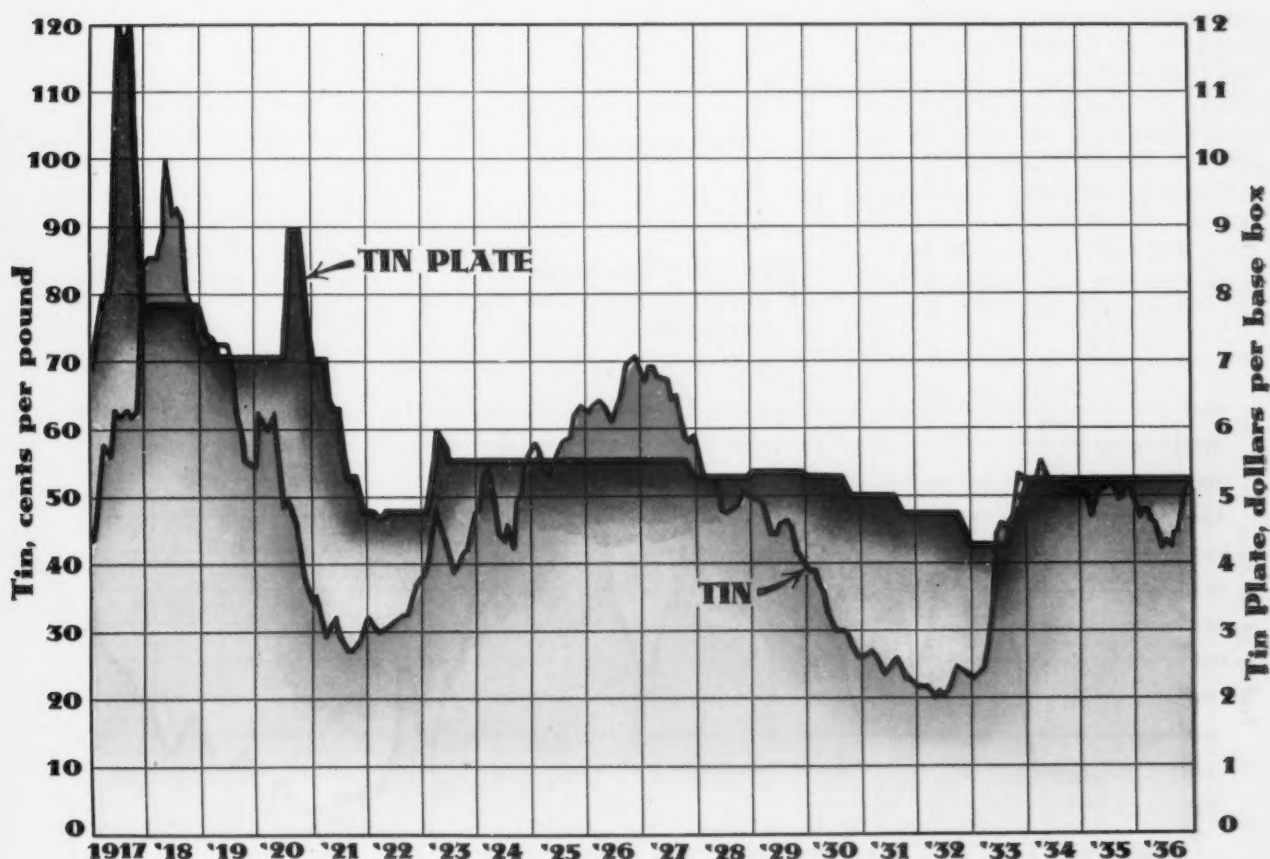
Contrary to the propaganda of outside labor organizations, events in 1936 have definitely shown that the plan of employee representation is not a "tool of management." No one knows this better than management.

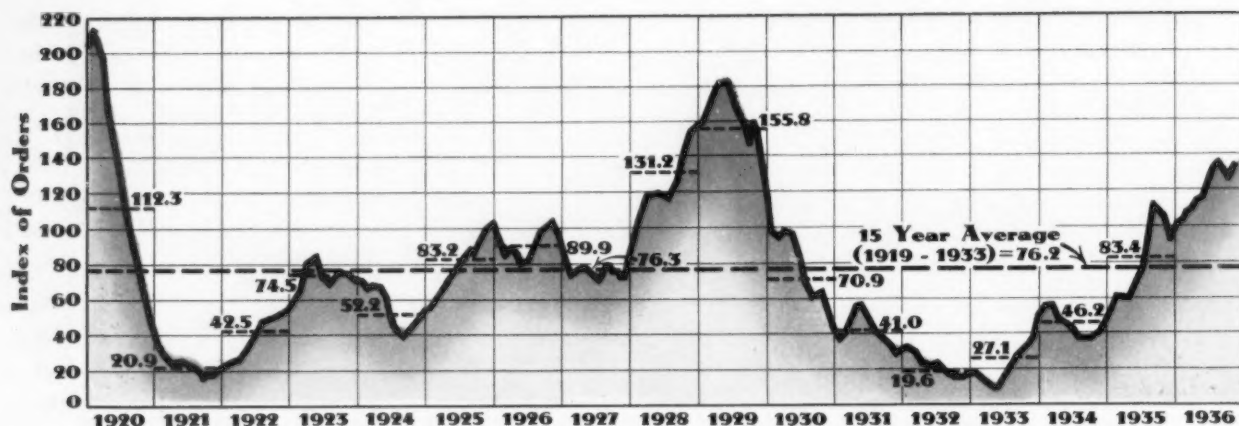
The plan has been refined throughout the year by the representatives themselves and aside from many minor demands, two-thirds of which have been settled in favor of the employees, the so-called "company union" has to its credit vacations with pay and a universal wage increase in the steel industry. Several of the committees of various plants in large steel companies have, through representatives of their own, established central bargaining commit-

tees whereby a comparatively small unit can expeditiously settle the more important problems on behalf of the thousands of constituents. An outstanding case of this kind is the Pittsburgh District General Council, composed of 34 employees' representatives and 34 management representatives of the Carnegie-Illinois Steel Corp.'s plants in the Pittsburgh and Youngstown districts. An interesting sidelight of this employee council was the election recently, as chairman, of a strong pro-Lewis adherent. Some dissension between opposing representative groups provided the circumstances by which the rabid pro-Lewis employee representative became head of the central committee. At a subsequent meeting, a vote was taken by the employee representatives on this central committee to unseat the employee chairman and, although 19 votes were cast against him, it fell short by two votes of the two-thirds majority necessary under the by-laws to recall a committee member.

The employee representatives have consistently attempted to gain

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**SHOWING the relationship between tin plate and tin prices**





a \$5 a day minimum in the steel industry predicated on their belief that the lower bracket employees should obtain a larger portion of any increase than higher paid workers. This request was turned down, but on Nov. 16 practically all steel companies raised wages an average of 10 per cent. One feature of the increase and one which caused considerable discussion was the introduction of a cost-of-living factor in the raises granted by the United States Steel Corp. The latter also put its wage increase in the form of a contract which was to be signed by the individual employee councils. The corporation granted a raise in anticipation of higher living costs and indicated that if the latter went 5 per cent beyond the 10 per cent anticipated an additional 5 per cent would be granted. The majority of employee committees in the corporation signed the contract, but still felt that the wage increases were not sufficient for the lower paid workers. Some

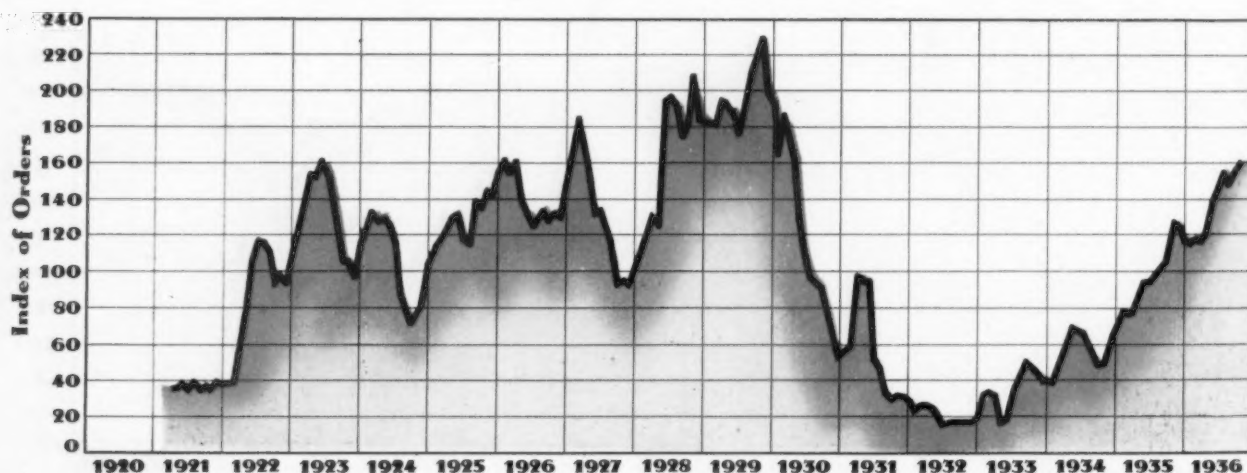
**M**ACHINE tool index showed strong upward movement in 1936

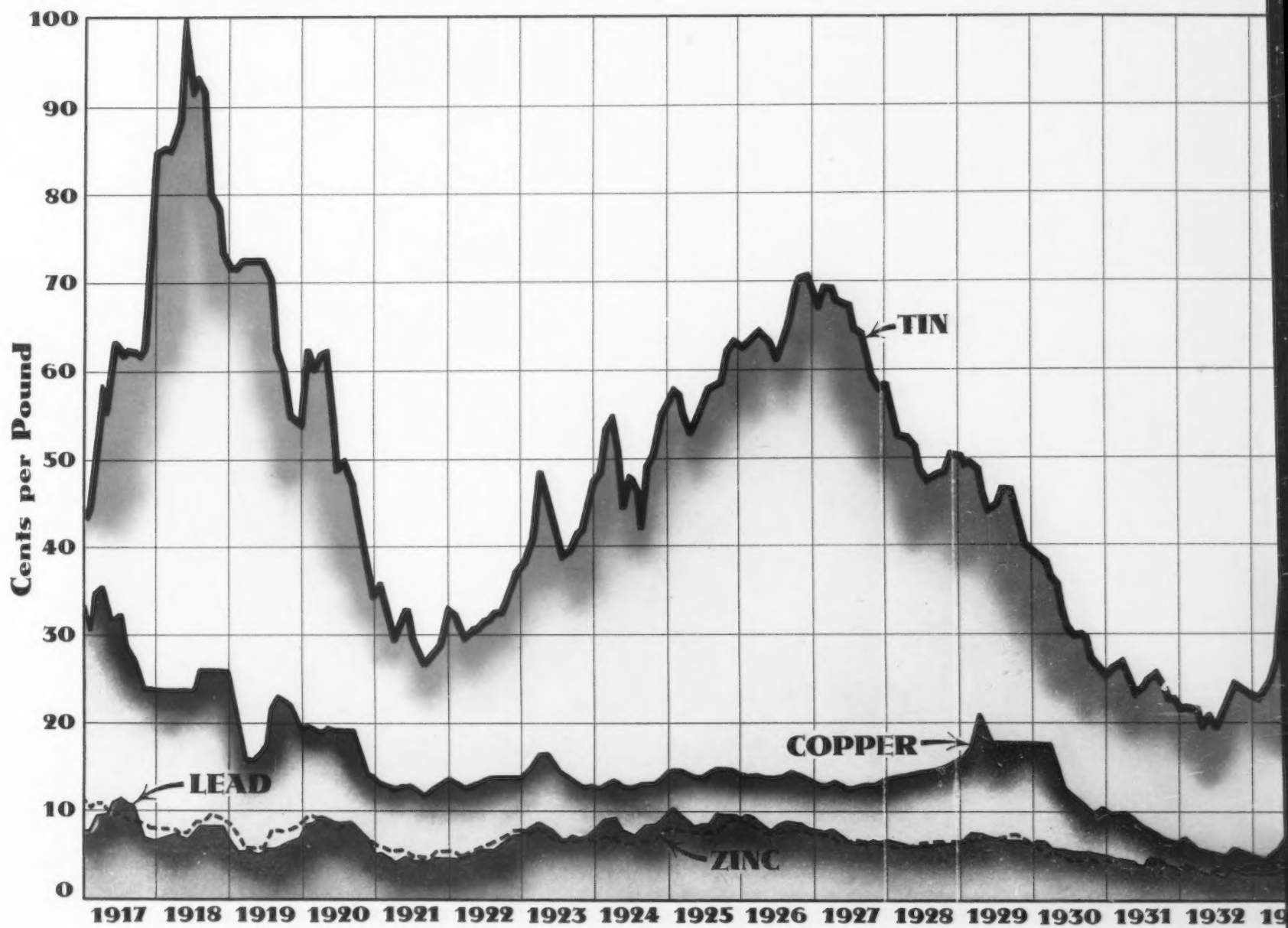
### Announcement

A CUSTOMARY feature of the Annual Review Number—the tabulation of new steel plant capacity installed during the year and that under construction or contemplated in 1937—is omitted from this issue in order that it may be presented more completely than was possible at this time. This feature will appear in the issue of Jan. 21.

**F**OUNDRY equipment orders continued the recovery to 1930 levels

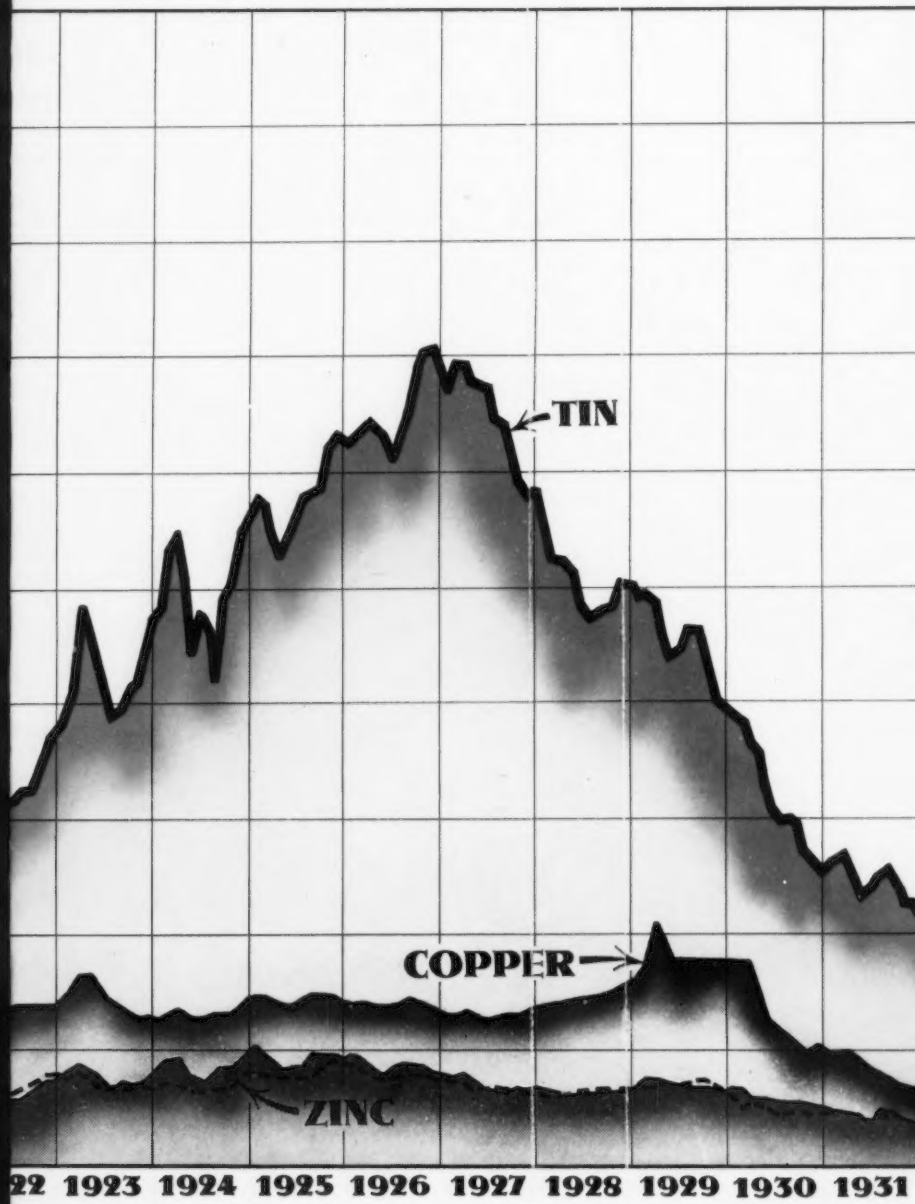
committees, however, refused to sign the contract, but their constituents were granted the same wage increase given to those whose representatives had acquiesced. The corporation was the only steel company which offered a wage increase involving the cost-of-living index or the signing of contracts. Wage increases granted in the independent steel companies averaged in most cases 10 per cent with all employees making between 47c. and 55c. an hr. having their rates boosted 5½c. an hr. In some companies the per cent increase for higher paid workers was less than 10 per cent, although other companies in addition to raising the common labor rates 5½c. granted a straight 10 per cent increase for all other classifications. White collar workers in the majority of plants had their salaries boosted between 7 and 10 per cent, but for the most part this was on an individual basis, the man's immediate superior deciding on the amount of the raise.





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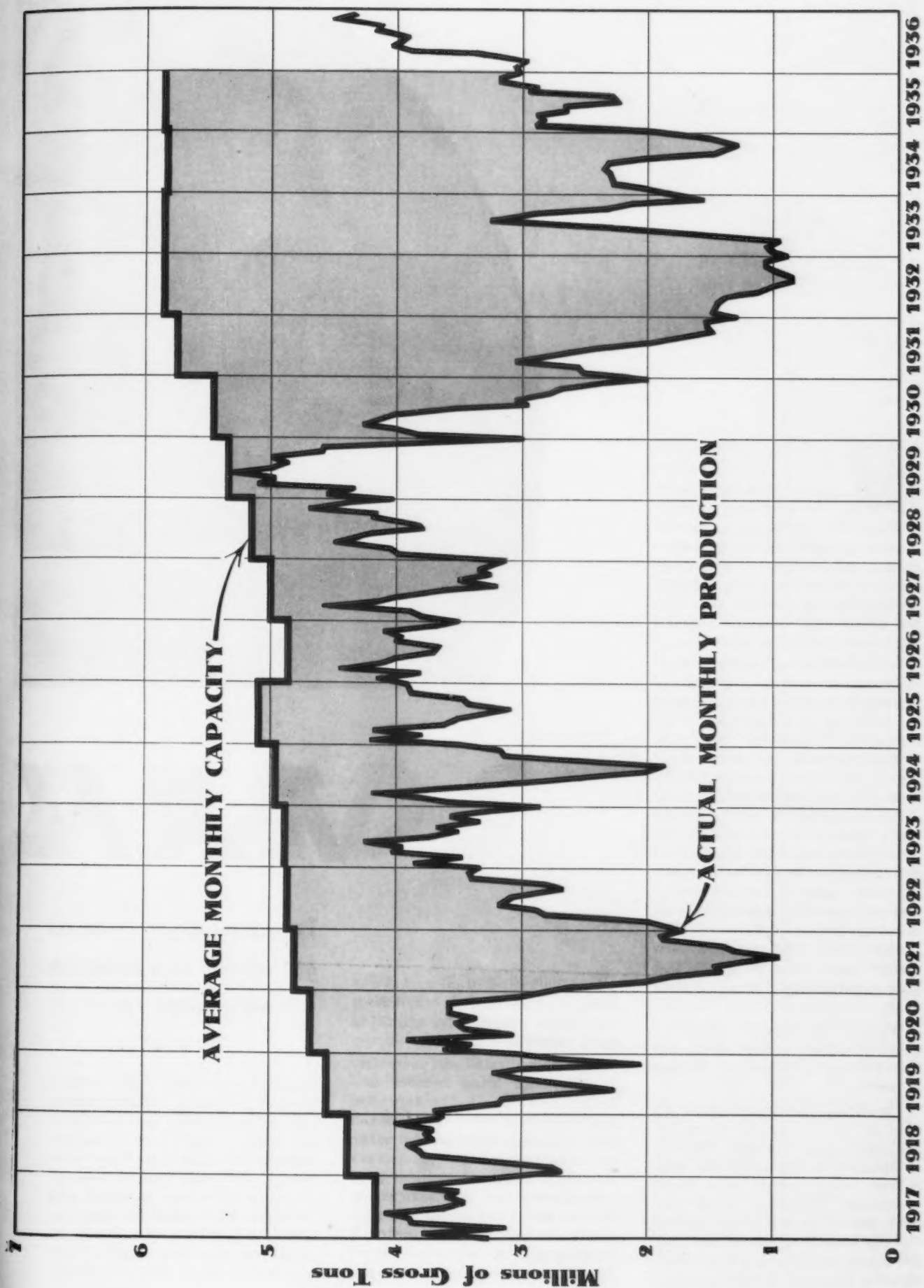


Com  
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*Contrary to the steadily rising trend in copper, lead and zinc prices during 1936 tin quotations only recently have turned upward*





*Steel Ingot Production Compared With Capacity*



AMERICAN railroads have gone in for rejuvenation on a large scale.

The past year's records of direct steel purchases, equipment orders, car loadings, net operating income, etc., all showed that prosperity is returning to the carriers, whose plans for the new year give full promise of reaching a peak for the post-depression period.

Review of accomplishments within recent years shows that net operating income has advanced from the 1932 low of \$334,324,999 to an estimated \$540,000,000 for 1936. Within the same period car loadings have climbed from 28,179,952 to an estimated 34,000,000. In 1935 direct purchases of iron and steel had increased 65 per cent from the 1932 bottom and 1936 figures thus far obtainable showed the tendency to have been strongly upward. Freight cars and locomotives ordered to Dec. 1, 1936, more than doubled the 1935 totals. New freight cars placed in service last year exceeded any like period since 1930.

What of the future? After five years of strict economy there has been built up a tremendous backlog of needs.

Throughout the depression period tens of thousands of pieces of equipment were scrapped. The way is opening to replace these with rolling stock which will bring economies. Therefore, many railroads are not merely studying plans for the immediate future, but they are taking an extremely long range view. A prospective 1937 purchase,

say of 2000 cars, in all probability means that the railroad may have a long range program for acquiring up to 10,000 or more units.

High-speed trains and more frequent service bring roadbed and bridge problems to the fore and these problems are being attacked with the same vigor as are other operating factors. The public likes this spirit and it is responding in such manner that new enthusiasm is being added to railroad management's determination to hurdle all old barriers.

Problems confronted by the rail-

roads are constantly being studied by steel producers. Notable among recent contributions are the steels of higher strength and higher resistance to corrosion. They contribute to lighter tare weight of rolling stock, higher pay load and improved serviceability. Stainless steel is now specified for structural as well as trim uses. Roller bearings which impose strict steel speci-



# RAIL

*Transportation systems  
go in for rejuvenation  
on a large scale*





Robert Varnall Richie

# ROADS

**Equipment orders largest in years and new types of trains adopted**



fications find constantly widening application and the art of welding steadily gains. Forged and heat treated alloy steels contribute to added strength and lighter weight. These factors embodied in the application of roller-bearing main and side rods, together with nickel-steel crossheads, piston rods and pistons on the New York Central's Commodore Vanderbilt saved 1000 lb. in

weight of reciprocating parts; permitted locomotive speed to be raised 30 mi. per hr.; and decreased hammer blow, thereby increasing track life and lowering wear and tear on the locomotive. Aluminum alloys are contributing their part as evidenced by the new Denver Zephyrs of the Burlington Route. Alloy steel castings contribute heavily to the success of the railroads' efforts. Controlled cooling, normalizing, and even heat treating of rails, enter the picture and when it comes to wheels all interested are striving to fulfill the exacting requirements of brake

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By **ROGERS A. FISKE**  
*Western Editor, The Iron Age*

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applications applied to high speed trains.

Car builders have learned that a structure designed for riveted assembly is one thing and that if a welded structure is desirable a new design must be started from scratch. All-welded cars have been built and the type of construction is now a matter of the choice of the railroad purchaser. Cold-driven steel rivets have solved the early problems encountered when assembling aluminum alloy structures.

## New Type Trains

Typical of what the railroads are offering the public in the way of speed and comfort are the new 12-car Denver Zephyrs now operating between Chicago and Denver on a 16-hr. schedule for the distance of 1035 miles. These are stainless-steel shot-welded units manufactured by Edward G. Budd Mfg. Co. Each train is equipped throughout with roller bearings; it is fully air conditioned to the point where an air curtain restrains cooking odors from entering the seating area of the dining car. Passenger carrying cars are wider than standard. Telephone service is extended through each train; 110 volt a.c. outlets serve standard voltage electrical appliances; and individual radios are available for each drawing room, bedroom and compartment.

Each train is powered by two diesel-electric cars, the first containing two 900-hp. units and the other one 1200-hp. engine. In the third car is an auxiliary diesel-

electric plant which operates the air conditioning and lighting systems.

The Union Pacific and the Chicago & North Western step out their streamlined train, which makes the 1048-mile Chicago-to-

Chicago to St. Louis streamliner on a 4-hr. 55-min. schedule for the 294 miles. This train makes a round trip daily and it supplants two steam trains. It was built by Pullman-Standard and it is powered by a 1200-hp. Electro-Motive diesel-

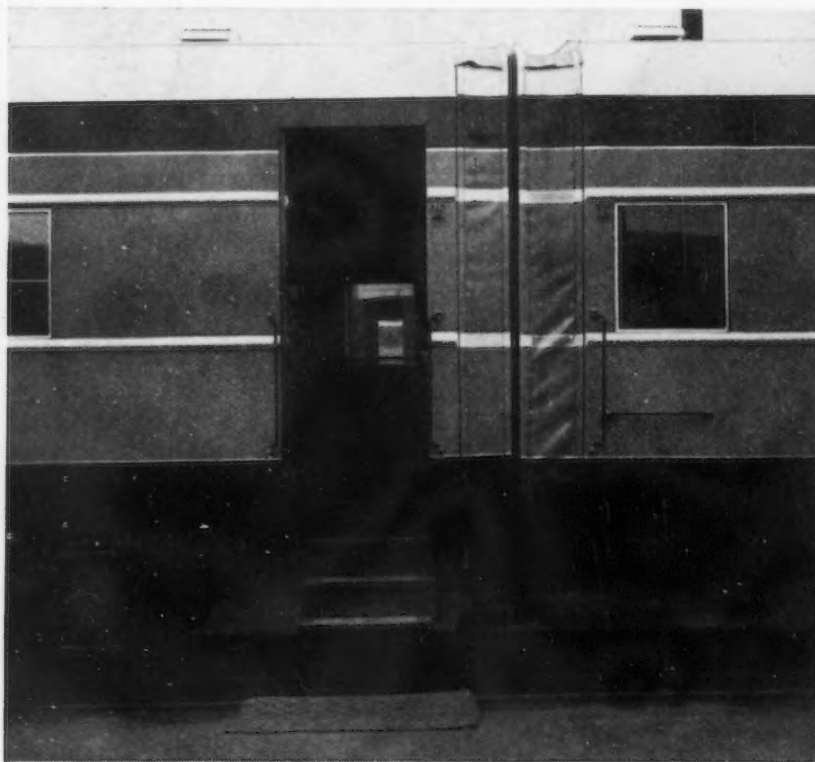
less than that of an equivalent steam train.

Local main-line and branch runs also attract new designs. The New Haven has put in operation a Besler steam powerplant unit which is designed for 1500-lb., super-heated steam in two-cylinder compound engines.

This design has the advantages of light weight, economy of operation, and low space requirements for the power unit. Fuel oil is used though similar units are operating in Europe on coal and coke. Working pressure on the boiler is attained from the cold in 4 min.

Late in November the Rock Island ordered six 1200-hp. diesel electric powered streamlined trains of three and four passenger car lengths. They are to be used to speed service on round-trip runs between Chicago-Peoria, Ill., and Des Moines, Iowa; Kansas City and Denver; and Kansas City and Minneapolis.

Experimentation as to type of motive power as well as to type and design of passenger equipment for high speed service has been varied and it is still going through the practical laboratory stage. The Chicago & North Western led off with its fast "400" between Chicago and Minneapolis. The train was made up of standard equipment



**A** TYPE of car for high-speed service, built of high-strength steel, equipped with roller bearings, of which the Milwaukee Road has built 37.

Denver run at an average speed of 65.5 mi. per hr. These trains were built by Pullman-Standard Car Mfg. Co., and each consists of two diesel-electric power units and ten partially-articulated trailing revenue units. Each train weighs 1,268,450 lb. light. The two-unit locomotive is equipped with dual, 1200-hp. Electro-Motive Corp. diesel engines. The chassis and bodies of these units are built of high strength steel whereas the cars in the train are built primarily of aluminum alloys.

Last month the Union Pacific and the Chicago & North Western announced purchase of new 17-car trains for the fast schedule run between Chicago and the West Coast. Each train will be powered by a 5400-hp., diesel-electric locomotive built in three units of 1800-hp. each.

Development of these types of trains is not confined to long run purposes. The Illinois Central operates its five-car, diesel-electric

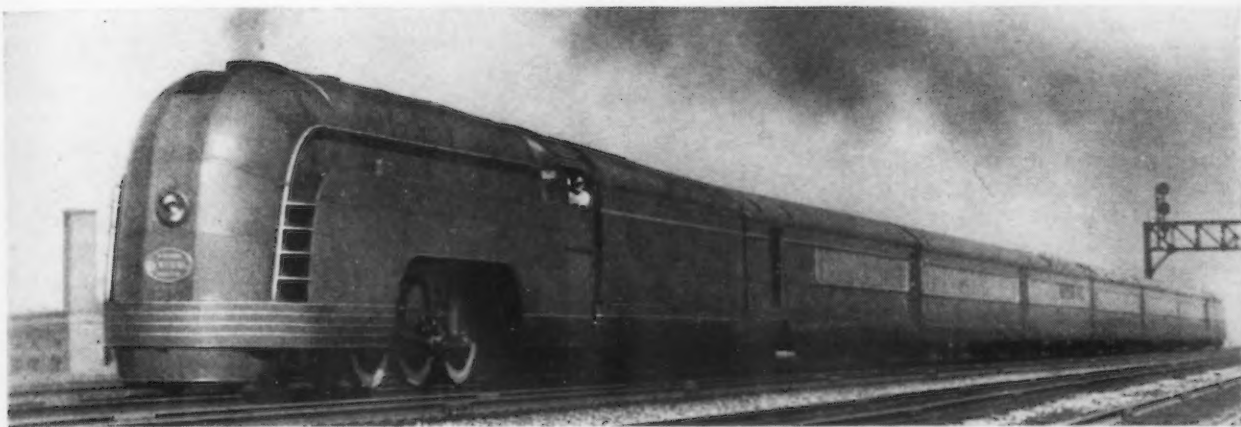


**D** DIESEL-ELECTRIC switching engines of improved design have been put into service by the New York, New Haven & Hartford.

electric plant. It is constructed primarily of high strength steel and aluminum is used extensively for interior finish and decorative features. Its construction required 6800 lin. ft. of arc welding and 5100 machine spot welds. The six trucks are roller bearing equipped and the weight of the train is 50 per cent

with the exception of the locomotive which was rebuilt for high-speed service and converted to an oil burner. Special equipment more or less following the ideas incorporated in other high-speed units is under consideration for this train.

About 18 months ago the Milwaukee Road put in operation its



**N**EW YORK CENTRAL'S new streamlined train, "The Mercury," operates between Cleveland and Detroit.

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Chicago-Twin City train which it christened the Hiawatha. Special coach equipment was built and American Locomotive Co. furnished specially designed streamlined steam locomotives. Month after month it has carried capacity loads and in August, 1936, its record was 34,119 passengers.

This success has led the Milwaukee Road to build in its Milwaukee shops three new, high-strength welded-steel trains, 37 cars in all, for the Hiawatha's run. These cars, which weigh one-third less than standard equipment, were placed in operation late last year. All cars are equipped with Timken roller bearings and full width diaphragms inclose the outer space between car ends. No change was made in the streamlined, oil-burning locomotives which are capable of a speed of 120 mi. per hr., and which make the 410 mi. run in 390 min. Each has four driving wheels, 84 in. in diameter, the largest on any locomotive in America. Clasp brakes are provided on both sides of all wheels to permit quicker stopping. Axles as well as other movable parts affected by friction are cased in grease or oil or operate on roller bearings, permitting smooth and quick acceleration. Alomite lubrication is used so no oiling or greasing is necessary en route.

Thousands of bolts usually employed in securing together different parts of a locomotive were eliminated by combining separate parts into one-piece steel castings, precluding the possibility of parts wearing or becoming loose. Loaded weight of the engine is 280,000 lb. and loaded weight of tender is 247,500 lb. Boiler pressure is 300 lb. and water capacity of tender is 13,000 gal. Fuel oil capacity of tender is 4000 gal. Maximum tractive power is 30,700 lb. A smoke elevator lifts the smoke so that it is carried off above the cars.

The Santa Fe, in inaugurating its 39¼-hr. Super Chief, which runs between Chicago and Los Angeles, took another view of the first step in high-speed train operation as well as the use of diesel-electric locomotives for main line work. It has been exploring the possibilities

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**O**IL-FIRED, steam locomotives of this type, built for the Southern Pacific by Baldwin, are used for passenger and freight service over the heavy grades in the Rocky Mountains, and operate cab-end foremost.

of applying the flexibility and economy of diesels to any kind of train for main line service.

For this purpose the Electro-Motive Corp. furnished a two-unit 3600-hp. diesel-electric locomotive, the two units being identical so that they can be operated singly or together, or coupled to any desired number of similar units, all controlled by a single operator. The weight of this locomotive is 250 tons and its overall length is 127 ft.

Its effectiveness has been proved in a number of ways, including the all important factor to the long-run Western railroads of long distance with a minimum of servicing and stops for water and fuel and locomotive changes. The boiler water problem, always serious in the West, has been eliminated.

The Santa Fe now has on order with the Edward G. Budd Mfg. Co. a high-speed, streamlined stainless-steel, eight-car train. Its weight will be about one-half as much as the standard train of an equal number of cars.

The Santa Fe is also having built two streamlined steam locomotives of most interesting design. They are intended for service on the Super-Chief, the Santa Fe's high-speed deluxe train running between Chicago and Los Angeles. The two new steam locomotives will differ in

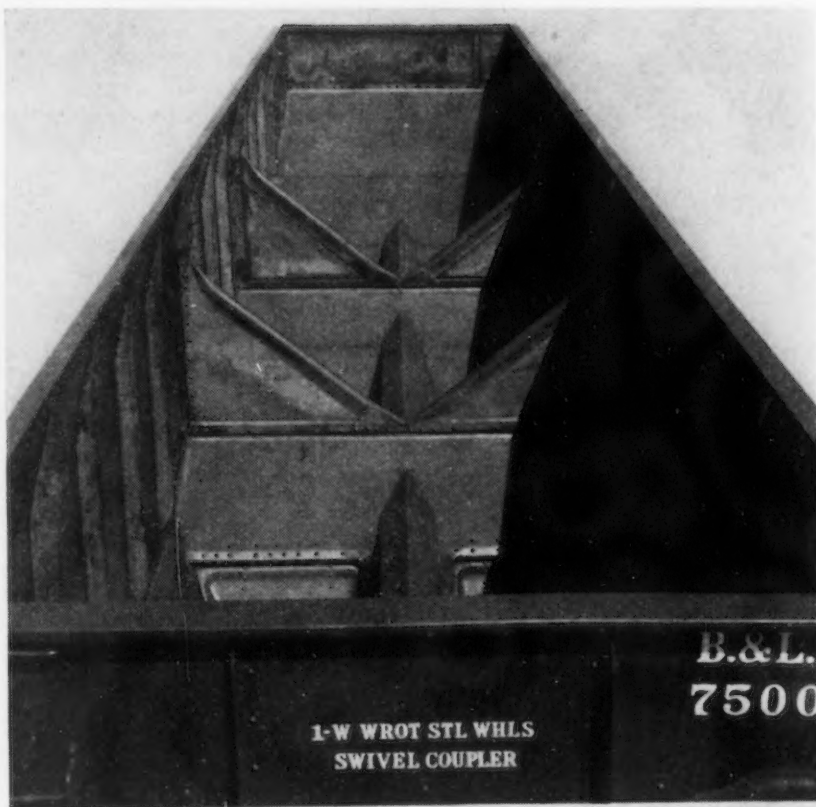


design, as one will have three pairs of driving wheels with a four-wheeled truck at each end; while the other, to be used on divisions where there are heavy grades, will have four pairs of driving wheels with a similar arrangement of trucks (4-8-4 type). When these new locomotives are in service, there will be an opportunity to make a direct comparison of Diesel and steam power, operating under identical conditions.

Coincident with the development of high-speed train service have been studies of the nosing characteristics of locomotives. Westinghouse Electric & Mfg. Co. has not only made field studies on the Great Northern but its research department has studied the problem on specially constructed locomotive models. This work disclosed that nosing is not caused by instability as a result of having the center of mass of the rolling stock too low, but that the oscillations are of constant frequency at all speeds. It was also discovered that any vehicle on a track and having the usual flexibility and spring suspension would start oscillating at some critical speed with the slightest lateral impact, and these oscillations would be sustained at constant frequency. It was further determined that a locomotive, if properly proportioned, can be made free from oscillations and safe at very high speeds. Critical speeds have been run up so as to increase safety and reduce track maintenance.

#### Diesel-Electric Locomotive Gaining Popularity

The diesel-electric locomotive is becoming increasingly popular for switching service at busy terminals



**A**LL-STEEL car built by American Car & Foundry Co. for Bessemer & Lake Erie.

where not only are economies important but smoke nuisance is a factor of operation. Typical of the new developments along this line are the General Electric switchers recently furnished to the New Haven Railroad. These locomotives are limited to 25 mi. per hr.; both trucks and cabs are of welded construction; and use is made of axle-hung traction motors geared to the axles by integral double reduction gears. Opposed-cylinder, high-speed, light-weight, water-cooled,

motor-driven air compressors are used and auxiliary power is taken from the main generator at both idling and full speeds of the diesel engine. Five locomotives are equipped with Ingersoll-Rand diesels and five with Cooper-Bessemer units. The New Haven truck is built up of structural shapes and plates knit together by heavy fillet and plug welds. The finished frame is rigid, tough and highly resistant to the shocks of normal service.

The weight of the locomotive is carried entirely on nests of coil springs mounted between the truck frame and equalizers. The construction is simple and the riding qualities of the locomotive exceptionally good. Additional features are the combined side bearing and locking arrangement, and the truck swivel limiting member which is attached to the front cross tie, contacting pads on the draft gear housing. Lateral thrust of the axle is taken by thrust blocks mounted in the journal boxes opposite the ends of the axle.

Another page in the rapidly accelerated history of modern railroading will be turned early next year with the appearance on the Erie, Pa., test tracks of the General

o o o **T**HIS twin-unit, 3600-hp., diesel-electric locomotive will soon be drawing a stainless steel train on the Santa Fe run from Chicago to Los Angeles.



Electric Co. of a new steam-electric locomotive which is being built for the Union Pacific Railroad. This new passenger unit will carry a condensing steam turbine generating plant feeding electric power to traction motors. Electric power will drive traction motors constructed on the usual electric locomotive design. The many desirable constructional features of the modern high-speed electric locomotive will be incorporated in the design. Because of fundamental differences it is expected that the new locomotive will show a reduction in fuel consumption and a correspondingly low maintenance.

The new unit will be a double-cab locomotive, rated at 5000 hp. The two cabs can be operated together in the same manner as with electric locomotives. It will haul 1000-ton trains such as the Union Pacific Challenger or the Los Angeles Limited over the Los Angeles-Omaha route. Streamlined, practically smokeless, and provided with equipment for air conditioning, the new locomotive will be modern in every respect. The builders promise speeds of 110 mi. per hr. on level



THE streamlined, high-speed, steam-powered train called "The Hiawatha" found instant favor with the public. o o o

track and sufficient fuel oil for a long journey will be carried.

A new, highly efficient type of steam boiler has been built, and tests give ample assurance of power to meet the exacting requirements of the locomotive. The high steam pressure and use of condensers are in line with the latest practice in

modern powerplant construction. The boiler will use fuel oil similar to that employed by other locomotives on railroads today, but the method of combustion will be more accurately controlled to obtain the maximum amount of power from a given quantity of fuel. The almost perfect combustion will insure practically smokeless operation.

#### Locomotives Streamlined

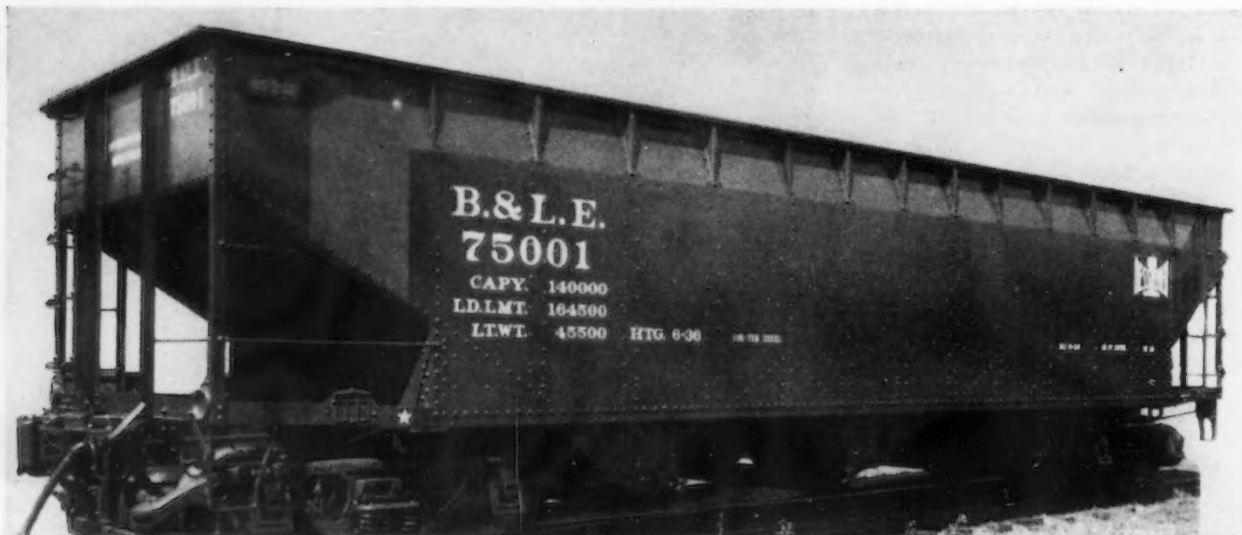
Designers of steam locomotives are taking advantage of streamlined design. The locomotives for the Hiawatha and the Mercury are examples. The New York, New Haven & Hartford has 10 streamlined steam locomotives under construction at the Baldwin plant. These locomotives will have three pairs of driving wheels, a four-wheeled leading truck, and a four-wheeled trailing truck, and will be covered with a hood, or cowl, designed to reduce wind resistance. Such a construction is of little benefit at speeds below 60 mi. per hr., but present-day schedules require speeds considerably in excess of this, and the streamlined construction then effects a saving in power, especially when running against head winds.

A serious problem in many large locomotives with comparatively small driving wheels is to so "balance" the wheels that destructive blows will not be delivered to the rails when running at high speed. With heavy machinery parts, sufficient weight cannot be put into the "counter-balance" of the main driving wheels to insure smooth riding.

A new type of driving wheel, known as the "disk wheel," over-

AN end view of freight car, shown on preceding page, built for Bessemer & Lake Erie. Plates and shapes were of Corten, forgings of Manten and other parts were of alloy cast steel.





comes these difficulties. The metal is so disposed that the axle and crank pin hubs are lightened, and there is more space for the counter-balance. Trouble experienced on account of shrinkage cracks in the spokes of the conventional type of wheel is eliminated, and with a sturdy rim construction and a dished section between the rim and hub, the pressure of the rib on the tire is equal all the way around the wheel.

These disk wheels are coming into use on new construction and they have, in several instances, replaced poorly balanced wheels on existing locomotives.

One of the most important subway and elevated developments has been the decision of the Brooklyn-Manhattan Transit Co. to proceed with the construction of 25 five-section trains similar in general to the two trains tried out in 1934.

Fifteen of these five-section units will each be equipped with 12 General Electric 70-hp. motors and type PCM controls. In addition to the usual air brakes, eddy current braking is also provided. High acceleration and braking will permit an appreciable increase in schedule speed.

New installations of trolley coaches have been made in Boston, Providence, Dayton (Oakwood Street Railway), Cleveland and San Francisco. In Philadelphia new coaches are replacing vehicles which have been in service since 1922. Sixty-one new all-steel vehicles—a combination of trolley coach and gas-electric bus—have also been placed in service by the

#### ABOVE

750 of the cars illustrated above were built for the Bessemer & Lake Erie.

o o o



Public Service Coordinated Transport Co. on its lines at Camden and at Newark.

Interest of street railway operators centers on the new Electric Railway Presidents' Conference Committee cars, 100 of which have been constructed for the Brooklyn & Queens Transit Corp. in New York.

These cars will incorporate numerous changes and improvements developed by the committee since the initial operation of the trial car in Brooklyn and elsewhere. The Chicago Surface Lines are now installing a fleet of these new streamlined, fast, noiseless, and modern street cars.

High strength steels are holding an important place in freight car construction. Their use in building a car, which if made of the older materials would weigh about 44,000 lb., will show a saving in weight of

from 8000 to 10,000 lb., which becomes available for pay load. Welded design is becoming increasingly popular, not only for the superstructure but for center sills, body bolsters, coupler lugs, etc.

The Pullman-Standard Car Mfg. Co. has designed steel refrigerator cars with weight savings from 10,000 lb. to 13,000 lb. per unit. The car body is of light-weight design built up by arc welding, spot welding and riveting. Welding is used almost exclusively in fabricating unit assemblies. High-tensile, corrosion-resistant steel is used for the underframe, side frames, superstructure, side sheets, end frames, end sheets, roof structure and roof sheets. Steel draft lugs welded in place are also a feature.

A new type of box car, with a large portion of the interior constructed of stainless steel for use in the sugar industry, has been an-

nounced by the General American Tank Car Co., Chicago. Unique in design, it boasts of a number of advantages over the conventional car, chief of which is its ability to carry double capacity load, or approximately 80,000 lb. The lining of the vertical sides, as well as that of the roof, is of zinc alloy. The hoppers are fabricated of Allegheny metal clad, a stainless steel manufactured by Allegheny Steel Co.

The bottom is composed of four hoppers in the shape of inverted pyramids. Eight separate hatches in the roof of the car provide for quick, easy loading, each hatch being carefully insulated to keep out dirt while in transit. The

roads' customers. Stainless steel, high tensile strength steel and aluminum alloys suggest the range of materials being used. Welding by numerous methods finds application on a broadening scale. The lighter structures suggest smaller power units and operating economies. Wind resistance is a factor in design because it is the highest retarding factor when operating a train on level track at speeds greater than about 60 miles per hr.

Truss type car frames are supplanting the older steel girder plate side frame construction, with resultant saving of weight. They are of all-welded construction and the side sheets form only an envelope for the car frame-work.

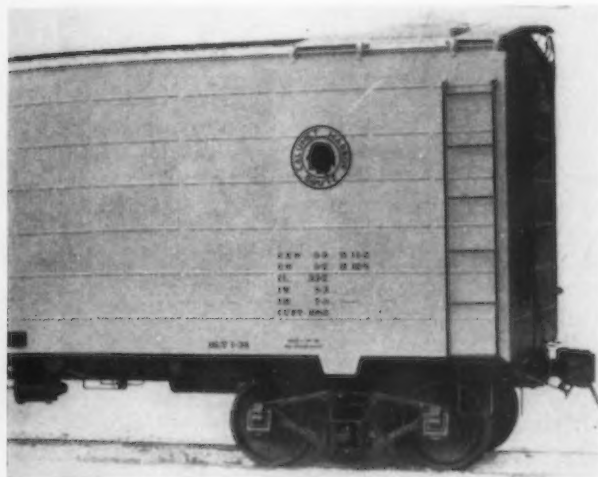
Terrific conditions imposed upon wheels by braking on high-speed trains is a subject of constant study both by the railroads and wheel manufacturers. Rolled steel wheel producers are constantly adding to their store of knowledge concerning requirements and improvements are coming fast.

The chilled-iron wheel group has improved the factor of safety by closely controlled annealing practices. A further step forward is that of having an association inspector in each wheel foundry, reporting to the association.

The single-plate design of chilled wheel has been improved. Demand heard a year or so ago for a lighter weight wheel has subsided. Such a wheel was designed and is ready for production but the railroads seem not anxious to put it into service.

Steel mills are particularly alert to the changing requirements for rails. Of special interest is experimental work being performed on long rails consisting of a varied number of standard lengths welded end to end thereby eliminating numerous joints and resultant maintenance problems. Tremendous strides forward are being made in controlled cooling, normalizing, hardening of the rail ends, and heat treatment of the entire rail. The last-named practice carries with it a high extra and therefore heat-treated rails find few practical applications at present. The future must tell its own story.

Controlled cooling consists in the main of moving rails from the hot bed above the 900 deg. Fahr. point



AT LEFT  
ALL-STEEL refrigerator car built of high-strength steel.

o o o

BELOW  
THE American Car & Foundry Co. built cars of light-weight steel, as shown below, for Chesapeake & Ohio.

interior surface of the Allegheny metal hopper coming in contact with the sugar is highly polished, with the result that possibility of caking is eliminated, thus assuring a rapid, easy flow of the sugar during the course of unloading and securing freedom from metallic influence of foreign taste.

#### Light-Weight Passenger Cars

Neither the car builders nor the railroads are taking these new constructions and methods for granted. There will soon be available impact test data, which are being taken on the Mount Vernon light-weight car which is under test in the Monon yards, Lafayette, Ind.

Passenger equipment design is moving swiftly toward light weight coupled with adequate strength, serviceability at high speeds, easy riding qualities, and, ever-increasing comfort and service to the rail-



## Railroad Equipment Orders in 1936

Statistics compiled by Railway Age on railroad equipment ordered and built in 1936\* are as follows:

Equipment Ordered		Year	Orders for Freight Cars Since 1915			Total
			Domestic	Canadian	Export	
Freight cars for domestic service	54,224	1921	23,346	30	4,982	28,358
Freight cars for use in Canada	0	1922	180,154	746	1,072	181,972
Freight cars for export	526	1923	94,471	8,685	396	105,552
Total	54,750	1924	143,728	1,867	4,017	149,612
Locomotives for domestic service	466	1925	92,816	642	2,138	95,596
Locomotives for use in Canada	0	1926	67,029	1,495	1,971	70,495
Locomotives for export	12	1927	72,006	2,133	646	74,785
Total	478	1928	51,200	8,901	2,530	62,631
Passenger cars for domestic service	204	1929	111,218	9,899	3,023	124,140
Passenger cars for use in Canada	9	1930	46,360	1,936	1,200	49,496
Passenger cars for export	0	1931	10,880	3,807	151	14,838
Total	213	1932	1,968	501	77	2,546
Streamlined trains	15	1933	1,685	75	132	1,892
Streamlined cars	106	1934	24,611	12	1,323	25,946
		1935	18,699	2,421	110	21,230
		1936	54,224	0	526	54,750

Passenger car orders do not include new type streamlined trains.

Prior to 1918, Canadian orders included in domestic.

\* All 1936 totals to Dec. 21 only.

to inclosures where they slow cool to about 300 deg. after which they are again brought out into the open. Normalized rails are reheated from about 900 deg. to normalizing temperature and slowly cooled. Heat-treated ends are provided when specified.

From advancements in the practical realm of railroading one should look at the improvement in merchandising this important service. Motor coach feeders and bus lines are extending the field of railroad service. More frequent trains, air conditioning and faster schedules are attracting the public. Special sight-seeing and winter sports excursions are drawing new and old customers to the railroad coach.

Lower rates and improved service are also contributing to the comeback of American railroads. Typical of this trend is the Challenger, operated between Chicago and the west coast, 2200 miles, by the Chicago & North Western and the Union Pacific. Breakfast costs 25 cents, luncheon 30 cents and dinner 35 cents. There are exclusive

coaches for women and children, a trained nurse, free pillows, drinking cups, and porter service, individual reading lights, and air conditioning. The one-way coach fare, Chicago to the coast, is \$34.50 and the summer round trip rate is \$57.35. About \$4.25 covers all meals on a round trip. The public's answer is that this train carrying regularly five tourist sleepers and four coaches has been completely filled, both east and west bound, since its maiden trip a year ago. It often carries extra cars to meet the demand.

Improvement in freight service is not lacking. Cars are being equipped with special loading devices; fast freight is moving on passenger train schedules; pick-up and delivery are attracting shippers and fast package freight is vastly broadening railroad service.

Although at this writing figures on railroad equipment purchases for the full year 1936 are not available, the table on this page shows the record to Dec. 21. Freight cars ordered up to that date totaled 54,-

750, the largest number since 1929, when 124,140 were ordered, and inquiries that were likely to be converted into orders before the end of December indicated that the total of freight cars bought in the full year would be around 75,000. Locomotives ordered up to Dec. 21 totaled 478, the most in any full year since 1930, when 555 were purchased. Passenger cars ordered up to Dec. 21 were 213, against 403 in 1934, the best recent year. Not included in the passenger car total are 15 streamlined trains made up of 106 cars.

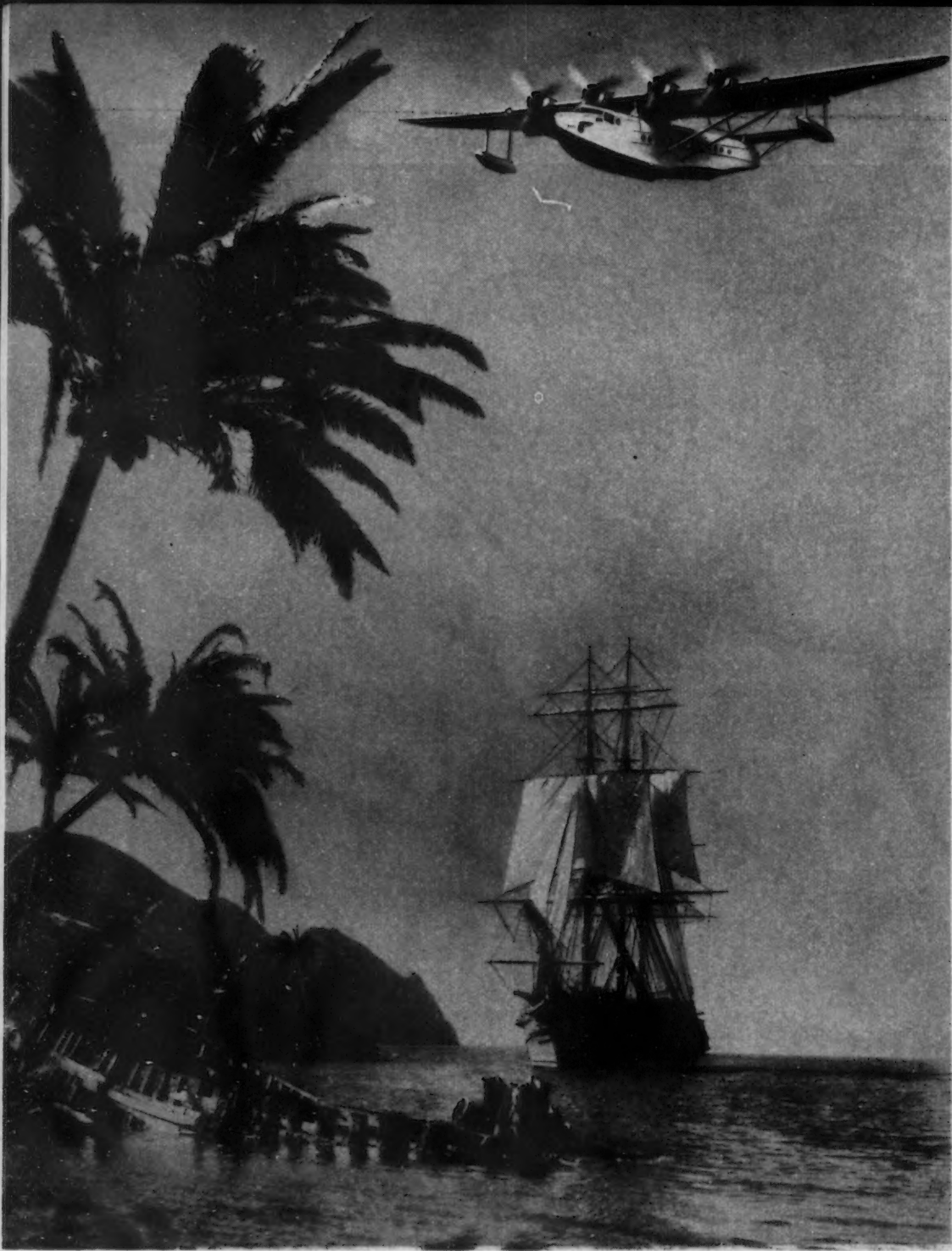
While purchases of new cars and locomotives may not be large during the first half of 1937, or until such time as equipment on order has been delivered, it is certain that a great deal of repair work will be done. Moreover, the further plans of the railroads as to equipment rehabilitation will be governed somewhat by events—that is freight traffic may be sufficient to necessitate further equipment buying before the time that it is normally expected.



*Alfred Cook*

° ° ° STEEL lends itself to gracefulness of design as well as ruggedness in this bridge that links three boroughs of Greater New York.

# A



*Pan-American Airways*

**W**HEN you see a mass of iron, aluminum and miscellaneous other metals weighing something like 15,000 lb. leave the ground, support itself on thin air and start off across country on a journey of 500 or 1000 miles, you are witnessing one of the most amazing developments of modern science.

That is what happens when one of the new all-metal air transport aircraft takes off, and it carries

along with its own weight of seven and one-half tons, about five additional tons of fuel, oil, equipment, passengers, crew, baggage, mail and express.

Metal has become a major material in aircraft construction, and its importance is increasing. Of the 7000-odd airplanes which hold Bureau of Air Commerce licenses, nearly 400 are of the relatively new all-metal type of construction which predominates among air

transport craft in this country. The others almost invariably have fuselages constructed on frameworks of steel tubing, and many of them have metal skeleton structures for the wings, the metal framework being finished off with the familiar fabric covering.

Aircraft engines, of course, are entirely metal and always have been, but fuselages, wings and control surfaces formerly were of other materials. The earlier air-

# V I A T I O N

*Metal has become a major material in aircraft construction as new developments in the art of flying make startling progress*

planes had wooden frameworks, braced with wire and covered with fabric. The structures did not have the streamlined shapes that are seen today, one reason being that the early designers did not know as much about streamlining as their successors do, and another being that it was more difficult to achieve the curves with braced wooden structures.

Wood is a good material from a number of standpoints, and still is used in many airplanes for wing ribs and spars. Wood is light and strong, and is easily worked. Its qualities are best adapted to parts where the stresses are those of compression. Spruce, in particular, is adapted to the purposes of the airplane builder. Plywood, built up of thin sheets of spruce or birch, has been used extensively.

Metal, on the other hand, is a material in which quality and characteristics can be controlled in the process of refining and manufacturing. It can be fabricated in shapes which are impracticable for wood. It can be used for compression or tension joints. The metals used in aircraft construction are subject to corrosion, but it is possible to provide protective coverings which will prevent air and water from attacking the metal.

The change from wood to metal

o o o  
By **GEORGE GARDNER**  
*Chief, Editorial Section, Bureau of  
Air Commerce, Department of  
Commerce*  
o o o

as the material for the structure of the airplane has been gradual. The first step consisted of substituting low-carbon steel tubing for the wooden members in the fuselage. At first these tubular members were braced with wire, as the wooden members had been, but a little later, tubing was used for the bracing as well as for the main members.

The introduction of chrome molybdenum steel provided an excellent material for the tubular members in the airplane. This steel is familiarly known as chrome moly, or as 4130X. The number is the S.A.E. designation. Originally, it was 4130, but a better combination of the same elements was found, and the new combination was termed 4130X. In chrome molybdenum the elements which are used along with iron are carbon, manganese, chromium and molybdenum. Its advantages

are superior cold-forming properties, adaptability for welding and susceptibility to improvement by heat treatment.

Airplane designers next considered the use of metal in wings. Steel tubing replaced wooden spars in many airplanes, and wooden ribs gave way to ribs of sheet aluminum alloy.

The aluminum alloy most widely used in airplane construction contains approximately 94 per cent aluminum, 4 per cent copper and small amounts of manganese and magnesium. This alloy has the peculiar property of hardening slowly after heat treatment. Rivets may be squeezed in, and sheets bent to shape while the metal is still soft after heat treatment. Then, after about eight hours at normal room temperature the metal becomes hard and much stronger.

Aluminum alloy is used for structural parts in sheets, extruded sections, forgings and castings. For protection against corrosion, it may be coated with a rust resisting preparation such as zinc chromate, or the surface may be anodized and then painted. A special type of sheet used extensively is a sandwich of aluminum alloy between very thin sheets of pure aluminum. This latter material needs no additional external



*Clyde H. Sunderland*

**A**IRPLANES span the Pacific with the regularity of railroad passenger service. The China Clipper over San Francisco Bay.

coating for satisfactory corrosion resistance.

Earlier uses of metal consisted chiefly of using metal parts where wooden ones had been utilized previously. The all-metal airplane, however, represents a new method of construction. The old type of inside framework, formerly wood and later tubular steel, has disappeared and instead we have a series of bulkheads at intervals along the length of the fuselage. The metal skin of the fuselage not only comprises the covering, or wall, but also constitutes the structure. Fabric, of course, is a covering only and does not take structural stresses. Frequently the stressed skin is reinforced with "stringers" which are long strips of U, Z or other similar cross-section riveted to the skin to provide additional strength and stiffness.

Wings of the all-metal airplane may have spars, either of tubular

steel, or aluminum alloy sections, or they may be cellular with vertical sheets of metal between the upper and lower skin dividing the wing into cells or boxes and providing all of the strength required for flight.

The aluminum alloy skin covering is fastened to the bulkheads or spars, and individual sheets are fastened to each other with rivets. Electric spot welding of aluminum alloy is a possibility, and has actually been used in members which do not carry vital loads; that is, at joints which could break without wrecking the airplane, and this method of fabrication is considered to have possibilities for the future.

Another alloy which has had applications in aircraft construction is stainless steel, which may be used without fear of corrosion and without necessity for protective coverings, and which may be spot welded. It has been used for wing ribs and other small parts

of the structure, and there may be an increase in the use of this alloy in the future.

A light weight magnesium alloy has been used in certain limited conditions such as castings for wheels.

Metals used in aircraft engines include special alloy steels for crankshafts, camshafts, connect-

ing rods, auxiliary shafts, gear valves, valve gear parts and linings of cylinders; aluminum or magnesium alloys for crank cases, cylinder heads, pistons, and housings for auxiliary drives; aluminum or magnesium alloy castings with bronze or steel moving parts for such parts as pumps or carburetors. The foregoing list is representative—there are other special metal uses, such as bronze or babbitt metal as plain bearings

for steel shafts and special alloy steel with very hard surfaces for ball or roller bearings.

Metal has achieved wide popularity for propellers. Many airplanes are fitted with forged aluminum alloy propellers, also propellers are being made of steel. The metal propeller can be thinner than a wooden one, permitting a more efficient shape.

#### Trend Toward All-Metal Planes

The all-metal type of construction, with supporting structure and covering all of metal, has been used chiefly in the large multi-engine types which fly on the air lines. To determine whether the method has possibilities also for the smaller types which are flown by private owners, the Bureau of Air Commerce of the Department of Commerce contracted with an aircraft manufacturer to build a two-place airplane of all-metal construction. This plane, the Curtiss-Wright coupe, has been delivered to the bureau, and now is being flown extensively by bureau personnel.

If the small airplanes of the future are all-metal this will mean new opportunities for the

metal industries, and a great deal of metal will be used even if the fabric-covered types prevail, for as has already been pointed out, the fuselage framework and often the wing framework is of metal in a fabric covered airplane.

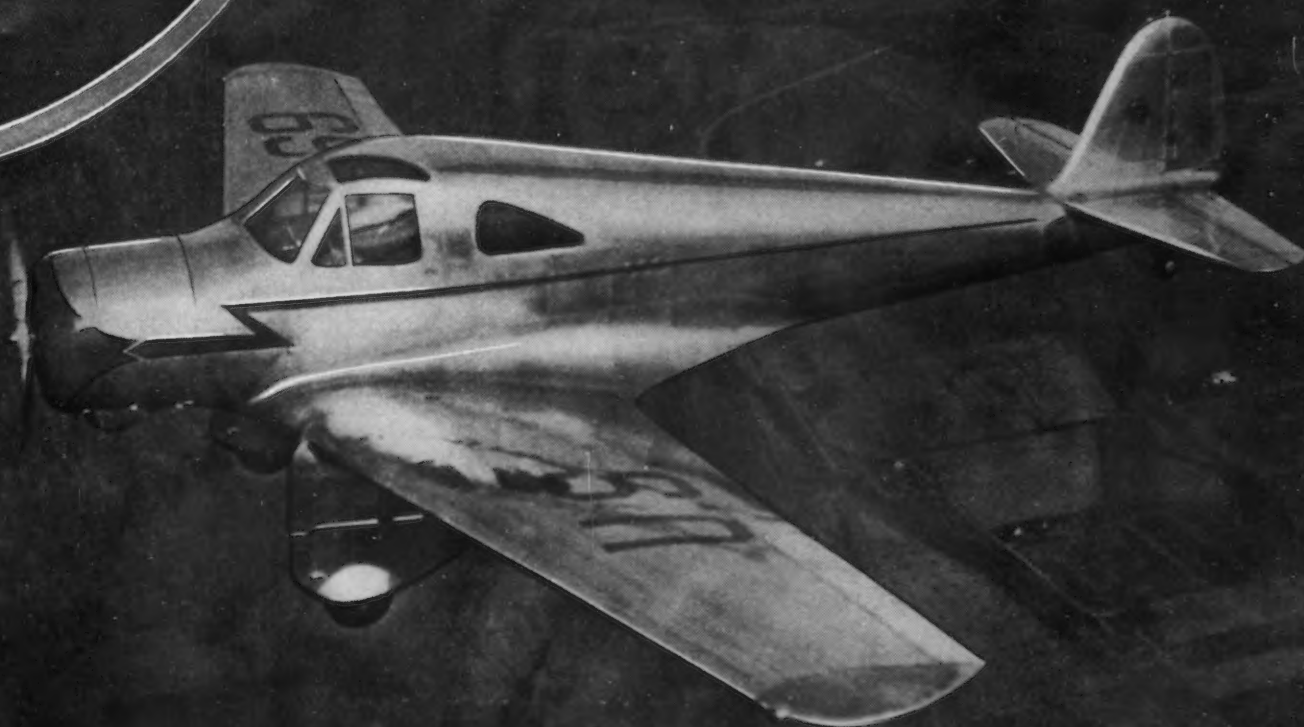
Metallurgical developments have gone along with aeronautical developments for years. Developments in metallurgy have made possible advances in airplane designing; the needs of the airplane designers have stimulated metallurgists to find the right alloy, with beneficial results to both the aeronautics and metallurgical industries.

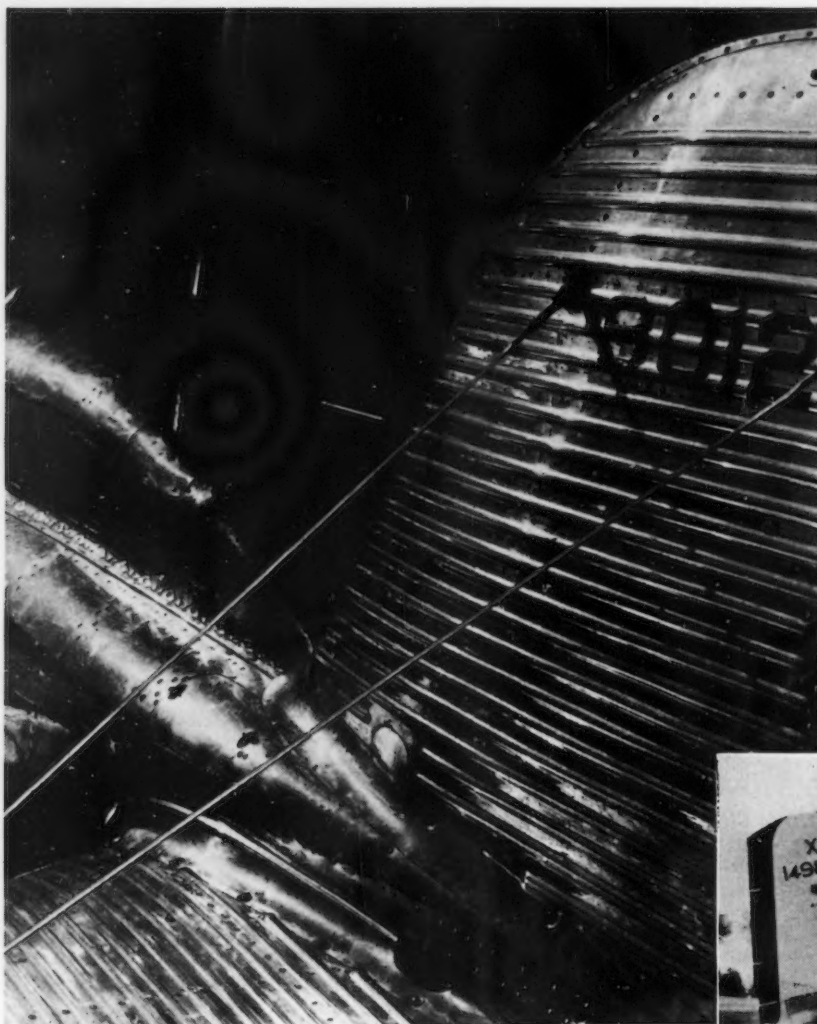
#### More People Flying

Thus, many of the readers of THE IRON AGE have contributed to the development of this new and speedy transportation medium which provides coast-to-coast service for mail, passengers and express on 16-hr. schedule, with proportionate time savings over surface travel on routes all over the country. It is a fast growing industry—in 1926 the air lines carried less than 6000 passengers; in 1935 the total exceeded 860,000. Indications are that the total for 1936, when reports have been received and compiled, will exceed a million.

The average length of an air passenger's trip is about 425 miles.

**A** CURTISS-WRIGHT coupe, a two-place, all-metal plane built for the Bureau of Air Commerce.





Robert Yarnall Richie

**M**ETAL becomes a more important material in the construction of airplanes (above).

o o o

Average fare paid is 57/10c. per mile. The scheduled air lines employ more than 9000 persons, including 692 pilots, 432 co-pilots, 2714 mechanics and riggers, 1535 other hangar and field personnel, 264 hostesses, 41 stewards, and 3392 office workers (as of June 30, 1936).

There is a great amount of flying activity by miscellaneous commercial operators and private owners, in addition to that done by the air lines. In the first half of 1936 these operators flew 41,000,000 miles and carried more than a half million passengers.

The aircraft manufacturing industry, showing evidence of recovery from effects of the depres-

sion, has increased its volume of activity. Producing 1363 aircraft in the first half of 1936, the aircraft manufacturing industry in the United States made a notable gain over the corresponding part of 1935 and produced more craft than were built during the entire year 1933.

Regulation and promotion of air commerce in the United States are functions of the Bureau of Air Commerce of the Department of Commerce. The bureau has established, and now maintains and operates, more than 22,000 miles of Federal airways, equipped with beacon lights, intermediate landing fields, radio stations for broadcasting weather information to

pilots in flight, radio range beacons and radio marker beacons for directional guidance and a weather reporting system utilizing teletypewriter circuits and point-to-point radio.

The bureau is responsible for examining and licensing airmen and aircraft and for enforcement of air commerce regulations and air traffic rules. For certain phases of aeronautics special regulations govern. The scheduled air transport industry, for example, operates under safety standards which are set up by the bureau's air line regulations and administered by its Air Line Inspection Service. Engineering requirements having to do with design and construction of aircraft are the province of the Manufacturing Inspection Service.

**A** DOUGLAS sleeper airplane constructed



There are special regulations having to do with schools, repair stations, administered by the General Inspection Service along with its duties of licensing airmen and aircraft, enforcing the air traffic rules, investigating accidents, and, in general representing the bureau in the field among non-air line pilots in regulatory matters. All of these regulations have safety as the fundamental and controlling consideration.

#### Government Fosters Aeronautics

The bureau also is charged with the responsibility of fostering aeronautics. Along this line, it has a development program seeking for advances in flying equipment. Six

new private owner types have been brought forward in this program—one being the all-metal airplane already mentioned—and other projects aim at improvements in engines, propellers, carburetors and instruments. The latest new airplane in this program is a twin-engined Lockheed 12-A all-metal airplane equipped with all the special devices used in air line operation including two-way radio, radio compass, de-icing "overshoes" on the leading edges of the wings and stabilizers, propeller de-icers, constant speed propellers, automatic pilot and radio antennas so mounted as to keep them free of ice. The Lockheed is being used by air line inspectors in connection with their work of examining air line pilots and checking air

lines, and for development work on air line equipment. In short, it is a "flying air navigation laboratory." Also, in writing the specifications to which this airplane was built, the bureau had in mind a relatively small type of air line plane which should be suitable for use by air lines on "feeder" routes—those short routes over which the loads of passengers, mail and express are not so heavy but which are important because they link additional cities with the trunk line air routes.

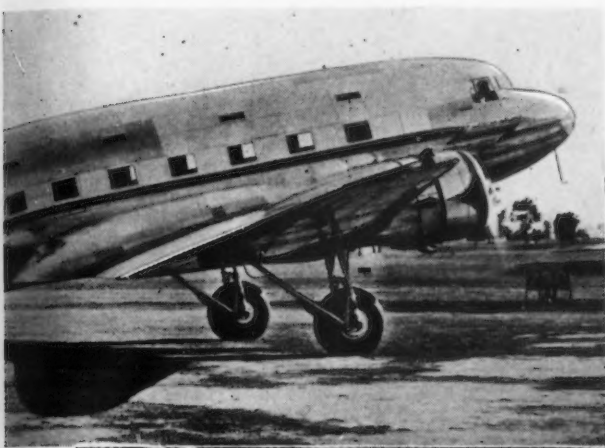
Another way in which the bureau is fostering aeronautics is through airport development throughout the country. Funds for airport development are provided by the Works Progress Administration, the Bureau of Air Com-

merce cooperating in the role of technical adviser, and passing on the suitability of each project and the plans therefor before it is released for operation by WPA.

Here, incidentally is another contact of the metal industries with aeronautics, for many of the projects have included buildings in which structural steel was used, lighting systems which called for wire and cable and other items of equipment constructed of metal.

Like many another industry, aeronautics owes a debt of gratitude to the metallurgists and metal manufacturers. Its progress has been linked on many fronts with advances in metallurgy, and in the future with extension of service across the oceans, and with airplanes of new types operating far above the earth in the sub-stratosphere, or perhaps the stratosphere, aeronautics will continue to look to metallurgists for aid in finding the solutions to many troublesome problems in airplane designing.

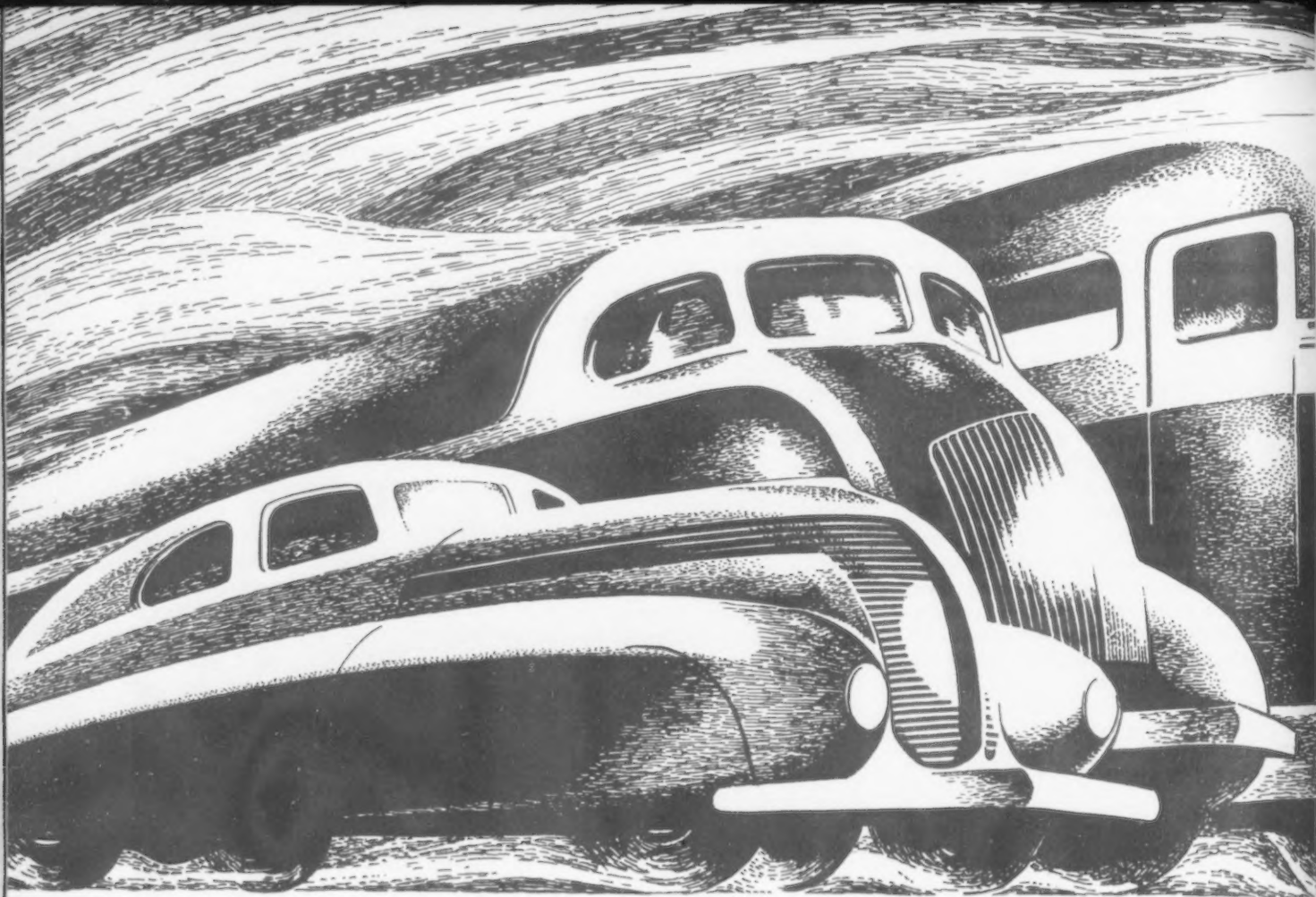
for American Airlines (center)     ○     ○     ○



#### BELOW

ONE may sleep in modern passenger planes as in a railroad pullman.





WHILE no such spectacular rise in total automobile production occurred in 1936 over the preceding year, as did 1935 production in gaining 44 per cent over that of 1934, nevertheless the year did record a substantial gain of over 400,000 units, or roughly 10 per cent. Production in the United States and Canada is estimated at 4,600,000 units compared with 4,182,491 in 1935. Automobile production has made full recovery to the numbers produced in the prosperity year 1928.

Consensus of opinion among informed sources is that 1937 will see between 5,200,000 and 5,300,000 vehicles produced. One analyst breaks down the total as follows:

	Passenger Cars	Trucks	Total
U. S. Domestic.....	3,900,000	725,000	4,625,000
Canadian, Domestic .....	140,000	35,000	175,000
Export (U. S. and Canada).....	275,000	150,000	425,000
Totals .....	4,315,000	910,000	5,225,000

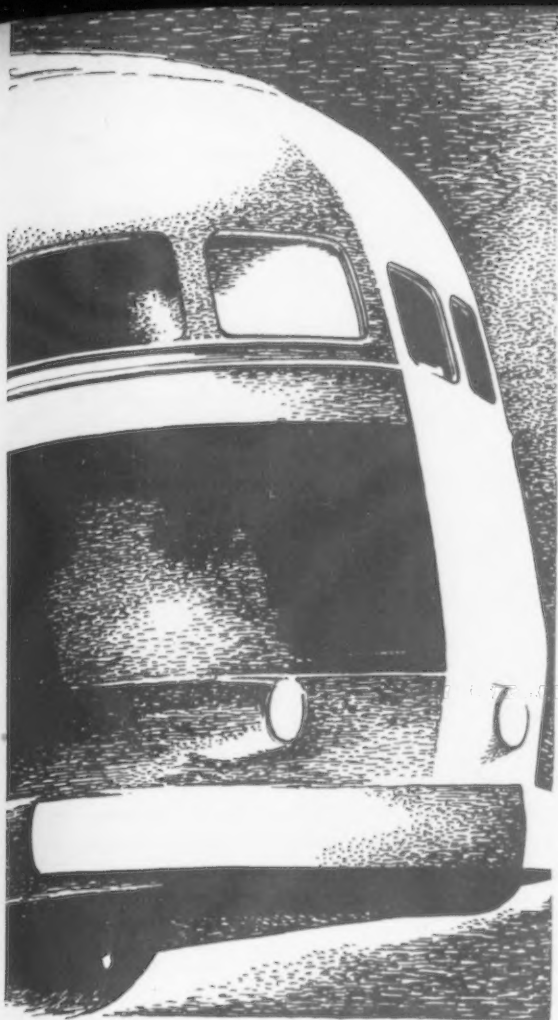
The largest factor is an increased domestic business, with Canadian and export markets practically stationary. Incidentally, the present capacity of the industry is estimated at 5,700,000 cars and trucks for a 10-month year.

That new car sales are definitely related to national income there can be no doubt. For three years running, since 1932, there has been a constant rate of increase of the wholesale value of automotive production for equal increments in national income, and this rate was twice what it was before 1929. But in the last year, this acceleration rate has been reduced. We have now reached the point where \$1

out of every \$25 of national income is being spent for automobiles, just as was the case in the twenties. In the depths of the depression, only \$1 in \$64 was spent for automobiles. National income was close to 60 billion dollars in 1936 when, roughly, 2½ billion dollars went into the motor car market. In 1937, national income should approach 70 billion dollars and the automobile industry should get a proportionate share of this increase, or 2¼ billion, assuming that the percentage going into this channel has now been stabilized.

#### Used Car Problem

There are a number of factors that may alter this generalization, however. The used car problem is the principal one, together with the concomitant one of average car life. Used car stocks are higher than they should be right now. Particularly is the market glutted



By FRANK J. OLIVER  
*Detroit Editor, The Iron Age*

# ***AUTOMOTIVE***

with recent models (there is a scarcity of cars built four and five years ago). Should dealers become overloaded this winter with used car inventories which they cannot liquidate until spring, many of them may be obliged to turn down new car sales. With an oversupply of used cars, prices will be depressed and allowances on trade-ins will go down. This may deter a new car prospect from completing his transaction, particularly should new car prices be increased as a result of increased labor and material costs. In fact, it is this very argument that is being advanced to demonstrate why it would be inadvisable for the manufacturers to raise prices, as some anticipate, in the spring of 1937. (At least 50 per cent of steel for 1937 runs has been committed for at third and fourth quarter prices.) Increased labor costs are offset to some extent by reduced

## ***Motor Makers Again Lead the Recovery Parade***

unit tooling costs, through spreading this cost over a larger number of vehicles.

On the other hand, since 1931 the relative prices of used cars have risen relative to new car prices, which declined somewhat and then were stabilized as between 1935 and 1936. Over a period of years the used car market

has grown steadily in relation to the sale of new cars. Since 1919 it has expanded from 50 per cent to almost 190 per cent of new car sales in 1936. The present state of the industry would indicate that an even higher rate is in sight. The explanation lies in the multiple turnover of used cars.

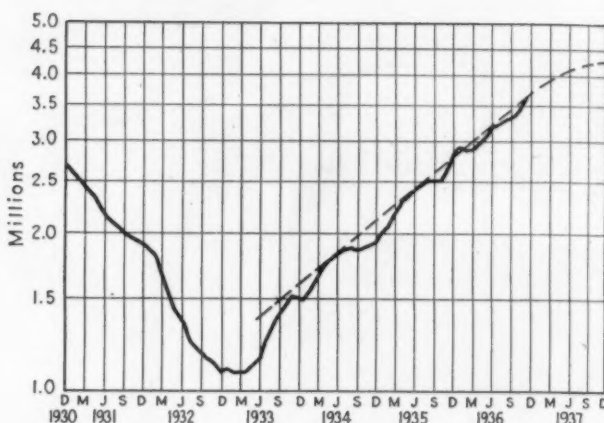
More liberal financing methods

on new cars have not helped to improve the dealer's used car problem. The number of cars, both new and old, financed on time payments rose rapidly in 1936, and the quantity of time paper outstanding rose at even a higher rate due to the extension of terms to 18 and 24 months instead of the customary 12 a few years back. Many analysts consider this an unhealthy factor and one that may have subsequent retarding influences.

#### More Mileage Per Car

One thing is certain, and that is that people are driving their cars more in a year. Since January, 1933, there has been a steady increase in fuel consumption per motor vehicle. There are also more cars on the road. Registrations of passenger cars as of July 1, 1936, were 22,300,000, compared with 20,700,000 in July, 1935. This figure established an all-time peak. A preliminary estimate as of Dec. 31, 1936, would place registrations at

A MOVING 12-month average of United States passenger car deliveries.



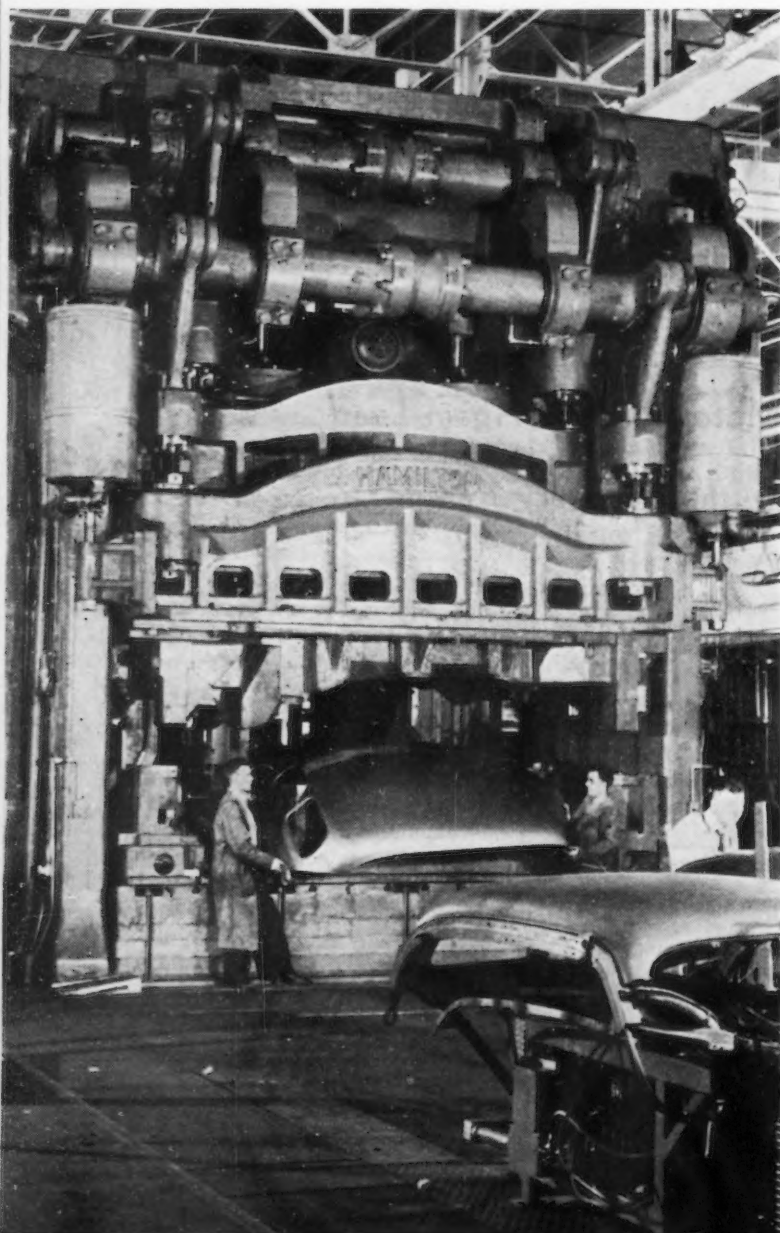
24,450,000 passenger cars and 28,420,000 cars and trucks—another peak. It means that wider markets are being found for used cars and are probably being extended into the lower income brackets, since 90 per cent of new car sales are to

former owners in the upper middle class. It is in this connection that the longer life, on a mileage basis, of a car enters the picture. Estimates of car life vary between eight and nine years, and any increase in car life will be reflected in wider car usage, rather than in a diminution of the new car market.

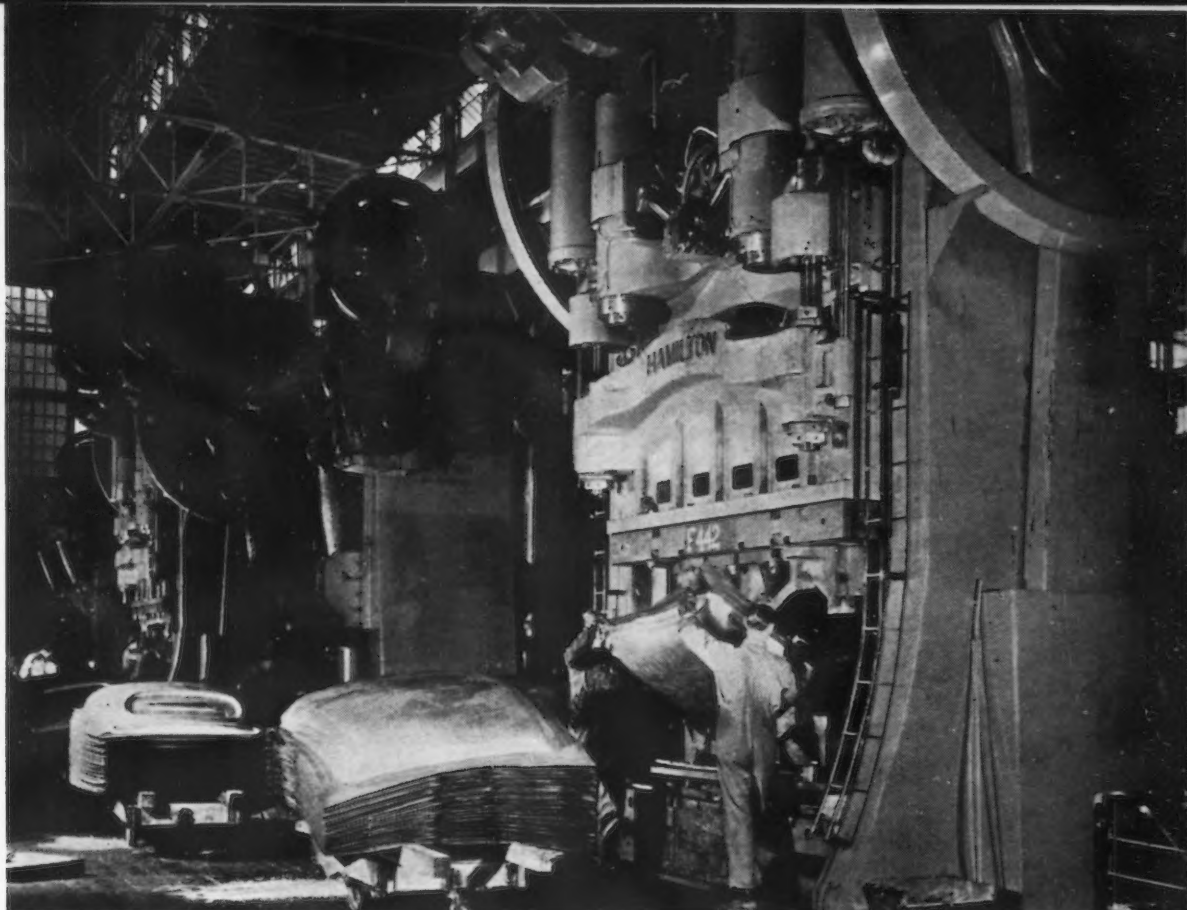
The obsolescence factor is a strong one, and the manufacturers can always advance design changes. Wide adoption of rear engined cars would represent such a move, but present thinking in the industry is against any such move until we have another major relapse. Average car life has no influence on the tactics of the typical new car buyer, who is governed more by his desire for a new product (obsolescence factor) and his ability to pay for it (national income). In poor times he runs the "old bus" longer. That is why car builders are looking to a faster turnover in 1937.

Reaction to the new models at the fall shows was very favorable and many makers reported large banks of unfilled orders by December. November registrations were disappointingly low, however, largely because of the inability of some of the largest producers to deliver cars. December registrations should exceed the 1935 figure by a considerable margin. Production was pushed to the limit in December to catch up with unfilled orders, which probably will not be reduced until the end of January. February should also be a high production month, unlike last year, when dealer inventories were deliberately reduced, only to have the

ONE of the interesting automotive developments of 1936 was the adoption of all-steel tops.



ALL-STEEL tops were made possible by the manufacture of wider sheets; heavier presses for this work were installed.



manufacturers caught off guard in the spring rush for cars. Dealer finances and used car inventories will largely decide this question, however.

Last year was a General Motors year, as far as volume and improved public demand is concerned. Its share of the passenger car market rose from 38.4 per cent to 42.9 per cent on the basis of returns already available. Ford's portion of the passenger car market fell from 30 to 23.5 per cent, whereas Chrysler's rose from 22.9 to 24.4

per cent. The independents shared 9.2 per cent of the market compared with 8.5 in 1935. Chrysler showed the greatest increase in profits per share of \$9.63 with earnings of \$41,975,327 for the first nine months, compared with \$23,184,457 the corresponding period in 1935. General Motors earned \$3.92 per share, in comparison, but total earnings for the first nine months rose to \$175,198,624—\$8,000,000 more than all of 1935 and an increase of \$60,000 over the nine-month period in 1935.

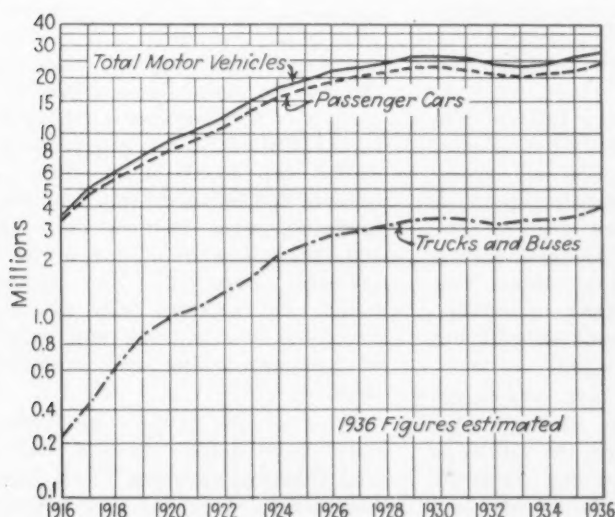
G. M. paid its shareholders \$4.50 in 1936, as against Chrysler's \$8.

Large expenditures were made by the industry for 1937 model tools and dies, new machinery, plant extensions and rehabilitation. General Motors alone spent over \$80,000,000.

The introduction of all-steel bodies cost the corporation \$10,000,000 for dies, \$11,000,000 for new machinery (mostly for the new Grand Rapids Stamping Division) and \$4,000,000 for rearrangement of production lines and equipment. Chevrolet spent \$26,000,000 for new machinery and tools for its new job. Buick tossed in another \$14,500,000 for general plant and equipment rehabilitation in addition to a similar amount spent the year before. Oldsmobile spent \$6,500,000 for new equipment and a new engineering building, while Pontiac spent \$3,000,000 for a new rear axle plant and an equal amount for other changes. The corporation put \$1,000,000 into an addition to the research laboratory.

Capacity of the Saginaw Malleable Iron Division was raised 15 to 20 per cent, making it the largest malleable foundry in the world.

Close to \$40,000,000 has been spent by the Ford Motor Co. since 1934, including \$10,000,000 for hot and cold strip mill equipment, the

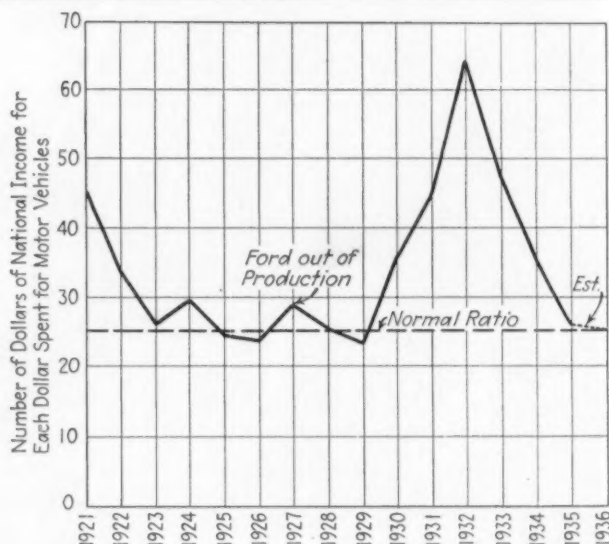


REGISTRATIONS of motor vehicles as of Dec. 31 in each year.

last of which went into operation in September, 1936. Ford's biggest expenditures are going into such large process equipment as new coke ovens (\$4,000,000); gas holder and distribution system (\$2,000,000), and a triplex safety glass plant (\$3,000,000); \$800,000 for modernization of blast furnaces, \$1,500,000 for installation of modern machinery in the foundry, and \$3,000,000 for machine tools and related equipment. The decentralized plant just completed at Northville, Mich., cost \$750,000, and \$1,000,000 was expended in bringing the Ford rotunda from the Century of Progress and re-erecting it at Dearborn. It is understood that approximately \$6,000,000 is currently being spent for tire-making machinery.

Chrysler spent over \$10,000,000 for plant changes and new equipment in 1936. Over \$5,000,000 went into the new DeSoto press shop and assembly line on Wyoming Avenue, Detroit, with a capacity of 500 cars a day. Practically a complete new line of machinery was installed at the Jefferson Avenue plant for a new six-cylinder engine line and component parts. Over \$750,000 worth of Gleason hypoid gear cutters went into Dodge Main to take care of all Chrysler rear axle units. Chrysler also purchased the former Wills-Sainte Claire plant at Marysville, Mich., and installed equipment for the manufacture and storage of service parts.

Of the independents, Packard invested the most in new equipment, largely as a result of the introduction of the Six. More than \$7,000,000 has been so expended. Consequently, Packard has one of the most modern motor plants of its capacity in the country. Included in this expenditure was a foundry modernization program in which four cupolas of 12 tons per hr. capacity were added. New molding machines, new sand-treating equipment and an elaborate conveyor system were also set up. Graham-Paige centralized all its operations at its Detroit plant, effecting estimated yearly savings of \$400,000 in manufacturing costs and increasing capacity by 50 per cent. In the new body department, transferred from Wayne, Mich., 1586 lin. ft. of body paint drying ovens were installed. Hudson confined its expenditures to new body dies and additional press capacity. In fact,



RELATIVE automobile spending is back to normal.

practically every company spent more on body dies than in 1935.

#### Average Weight of Cars Increased

The increase in average weight of cars has continued for the fourth consecutive year, and it is estimated that there is an average of 65 lb. more of steel in the typical 1937 car than in a corresponding 1936 car. There are a few notable exceptions to this generalization. By complete redesign from bumper to bumper, Chevrolet engineers were able to take 240 lb. out of the previous model's weight. The small Ford engine and transmission is 162 lb. lighter than its bigger brother, and the chassis for both has been lightened. Fenders are of lighter gage. Cadillac and LaSalle took hundreds of pounds out of the car, 85 lb. out of the transmission alone. Hence, one would not be justified in multiplying the estimated output of 1937 models to obtain the increment in steel usage, since the big volume cars are lighter. The fact that Fisher Body has adopted a Unisteel body for all except custom jobs will mean consumption of 35 per cent more steel, or 600,000 tons total by General Motors alone, assuming equal volume. This figure will more likely reach 660,000 tons on the basis of a 10 per cent increase in output.

All-steel tops are practically universal, and only on the Chrysler Airflows and on the Grams is the inserted-center retained. Fenders are deeper and wider and have called for increased drawing qualities in fender stock.

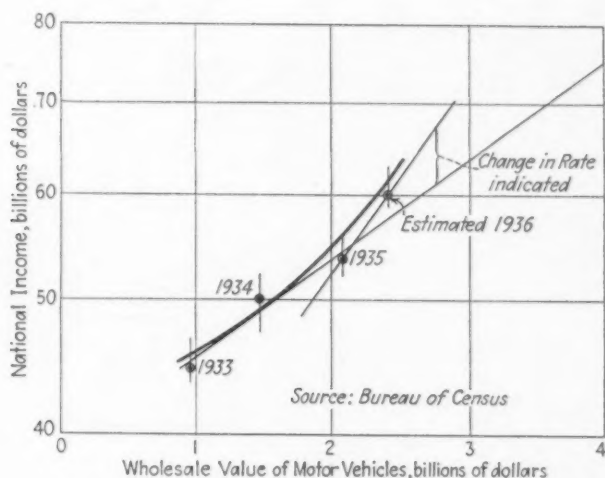
The use of stainless trim, mostly of the straight 18 per cent chromium variety, has increased tremendously. The stainless itself is made as thin as practicable and is snapped over a carbon steel rolled shape. This sudden increase in demand began to create a serious delivery situation on the part of the mills in furnishing this material. Biggest new use of stainless is to be found in the small Ford 60-hp. V-8 motor, wherein 16-6 alloy plates are spot welded to the under sides of each cylinder bank to seal the water jackets, left open as cast en bloc. About 2 lb. of stainless is necessary for each block, or 4000 lb. daily on the present output.

#### House Trailers

House trailer development made rapid strides in the past year. Hundreds of companies got into production, including a few leading firms that made as high as 300 units a week. Conservative estimates of house trailer production in the United States run between 35,000 and 45,000 units. Predictions of 200,000 units this year are fantastic, since even a total of 100,000 trailers would tax present available capacity. The house trailer has received wide acceptance, but has already run afoul of housing, zoning and sanitary laws.

Whereas the largest producers have been using plywood walls with fabricoid covering, in the last few months there has been a very definite swing toward the wider use of steel for trailer side walls,

# RELATION of national income to United States motor vehicle production.



chassis members and structural ribs. The question of insulation is paramount and is the main issue around which the arguments as between plywood and steel construction revolve. The entry of the Pierce-Arrow Motor Co. and the Hayes Body Co. into the house trailer field has tended to accentuate the trend toward metal exteriors and metal framing.

## Highway Safety

Realizing the adverse effect of mounting highway deaths upon the industry, last January the Automobile Manufacturers' Association set up a safety traffic committee to coordinate efforts to promote safety on the highways. Tire makers and parts makers as well as finance companies also participated. Direct grants were made to various groups who have taken active part in public safety work,

such as the National Safety Council and the International Association of Police Chiefs. Emphasis is placed on the three E's—education, enforcement and engineering. Uniform traffic legislation is also sought. A graduate school was set up and financed by the Automobile Manufacturers' Association at Harvard Business School to develop traffic engineers. In November current figures indicated that, although total traffic deaths had not decreased materially from the previous year, there was an increase of 20 billion miles of car usage, so that this national movement has netted that much mileage of safe driving which had not previously existed.

## Labor Problems

During the past year goodwill bonus disbursements to workers became common. General Motors

distributed \$10,000,000 in December in this way, and Chrysler, \$8,300,000 over the whole year. Both Briggs and Murray body companies followed suit and a host of other parts companies took similar action. Toward the end of the year both General Motors and Chrysler adopted a 40-hr. week with time and a half for overtime. General Motors raised wages 5c. an hr. in addition. Packard introduced vacation with pay to workers with a service record of over six months.

Most significant factor in labor relations was the rise in power of the United Automobile Workers International Union and its apparent success in settling sit-down strikes in strategic parts plants. The UAW was organized in August, 1935, but it did not show any signs of real life until after its convention at South Bend, Ind., in April, 1936. At that time innocuous Francis Dillon was defeated as a candidate to succeed himself as president, and a new group headed by Homer Martin took office. Martin is an ex-Baptist preacher, a reformer and idealist type, totally lacking in labor experience until that time. Merger on July 1 of two fairly strong local unions gave the UAW added strength. What gave the new group its main drive was the backing it received from John L. Lewis' Committee for Industrial Organization, which has largely been directing its strategy.

We close this review on the note that of all the "ifs" and "ands" of 1937 prospects, the biggest question mark must be placed after labor. An industry-wide shutdown due to lack of parts could knock any production estimates into a cocked hat.



○ ○ ○  
**H**ORSE and mule populations on the farms continue to dwindle and tractor sales are mounting.  
 ○ ○ ○



**R**ISING national income, growing farm income and five years of scant farmer buying point to a continuation of rising sales curves in all rural areas. Estimates place the 1937 national income at 10 per cent above the

1936 volume. The simultaneous rise of national income and farmer buying has always held in the past and present conditions show that normal influences are at work and the two curves are in step as they climb to higher levels.

Farm income for 1937 is esti-

mated at \$8,500,000,000, which will be about 10 per cent above 1936, about \$2,000,000,000 under 1929, but more than double the 1932 low. The Department of Agriculture forecasts that prices for farm products during the first half of 1937 will be above the corresponding

# RICULTURE . . .

*Despite the 1936 drought, the farm market for steel and equipment promises rising sales curves as rural income expands*

. . .

period of 1936, because of increased demand and short supplies. Prices in the second half of the new year will depend on the weather and general growing conditions. An important point favoring farmer purchases is the freedom of credit being extended both by governmental agencies and country banks. Interest rates are low and this condition is expected to remain throughout the new year. Notwithstanding depression experiences, the farmer remains an active borrower against future farm yields.

The influences of all these factors on the farm equipment industry have been apparent throughout 1936 and promise to extend well past the new year. Domestic sales in 1936 exceeded 1935 by 30 per cent and foreign sales rose 50 per cent. The tendency toward stabilization of foreign currencies promises more world-wide business. Farm equipment plants start the new year with satisfactory production schedules and excellent prospects for the future.

The cost of animal power is increasing far faster than variations of the mechanical power cost. Horse and mule populations in the United States continue to decline, the change having been 2.2 per

cent from 1935 to 1936. This fact adds sauce to the tractor builders' pudding.

#### **Backlog of Farm Building Work**

Farmers have not been diverting much of their income to new building construction and as a conse-

quence there is a tremendous backlog of such work. Farmers are most inclined to build up their production requirements first, and it cannot now be determined when they will divert more of their attention to farm structures.

In the field of new developments

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Annual Increase in Number and Per Cent of Farms Served by Central Stations in the United States Since 1924

Year	Number	Increase	Per Cent Increase
1923	177,561	....	....
1924	204,780	27,219	15.3
1925	246,150	41,370	20.2
1926	309,125	62,075	25.6
1927	393,221	84,096	27.2
1928	506,242	113,021	28.7
1929	576,168	69,926	13.8
1930	649,919	73,751	12.8
1931	698,768	48,867	7.5
1932	709,449	10,663	1.5
1933	713,558	4,109	0.6
1934	743,954	30,396	4.3
1935	788,795	44,841	5.7
1936	889,152*	....	....

Source—Edison Electric Institute.

\*This figure includes about 30,000 farms, added in previous years but not shown in the counts from 1923 to 1935, inclusive. Therefore, actual increase to end of September, 1936, is about 70,000.

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**T**HE all-crop harvester, tractor drawn, finds ready work in an Indiana soy bean field. o o o

there are several of outstanding importance. These are the crop drier and the basin lister. The former is in the early stages of development and has yet to be brought within the price range which will attract farmer buying. It will find wide use in lowering the moisture in grains and hay to 15 per cent content, which is desirable before storing. These fuel-fired driers will save losses incidental to ordinary drying methods, such as the loss of leaves resulting from the repeated handling of alfalfa. This equipment will open a new outlet for steel mill products, especially sheets.

#### Listers for Water Conservation

Basin listers hold excellent promise to come to the aid of the wind-swept area of the Southwest, which has been suffering so seriously from soil losses from both water and wind erosion. Moisture conservation is the important problem over most of the high plains area. Gully damming and impounding water will not do the trick. These methods only stop soil erosion and they may add some humidity to the air. They may also result in malaria, mosquitoes and stench. Further, in a dry season a crop will burn 100 ft. from the edge of a pond.

The basin lister stops the washing of top soil and results in holding moisture on the field where it soaks in and is retained for the benefit of the crop.

The lister, tractor drawn, plows three furrows, and damming attachments, which are automatical-

ly tripped, form dams across the furrows so that run-off is prevented. This operation, performed soon after the harvest period, holds rain, snow and top soil. Experiments show that a 2½-in. rain falling in 30 minutes can be held with no run-off, whereas adjoining fields, not basin listed but finely pulverized, lost 67.8 per cent of the rain with

loss of top soil at the rate of 17.1 tons per acre. A basin listed field has shown moisture depth of 30-in. and a successful crop, while an adjacent field not so prepared produced an exceedingly poor crop.

Another growing outlet for farm machinery is the tremendous small-farm area east of the Missouri River. It is rapidly dawning on these farmers that small tractor units are economically adaptable to their needs and that equipment builders are offering small tractor-operated equipment including combines which cut 5 to 6-ft. swaths. This trend is growing and no doubt will continue to grow.

#### Farm Electrification Progressing

The year 1936 showed marked increase in the progress of electrification of American farms. During the first six months of last



year more farms were connected with electric lines than in any 12-month period since 1929. Experience indicates that there is definite economic advantage in electric service for the poultry, dairy, fruit or vegetable farmer and for about 15 per cent of the general farmers. On livestock farms, other than dairy, and on cash-grain, tobacco and cotton farms the principal use for electricity is household purposes. An unevaluated advantage in all cases is an improved standard of living. Probably 40 to 45 per cent of American farms can use electricity to economic advantage.

Droughts of recent years have tended to accentuate development of irrigation projects. This work brings denser population along streams from which water can be ditched. This situation facilitates the problem of extending electric

service to the valleys. Irrigation pumping accounts for most of the electricity used on farms in California, where more kilowatt hours are used on farms than in any other State.

In general, most electrical current is used for lighting. Household appliances come next. Electric refrigerators are taking a strong hold as are automatic water systems, which in 1936 set a new high sales record. The electric range is being sought where fuel is expensive and where winters are not extremely severe. Combination coal (or wood) and electric ranges are growing in popularity. It has been estimated that to equip

a million farm homes with modern heating, plumbing and water systems, together with modern electrical appliances would represent an expenditure of not less than \$800,000,000.

On the dairy farm electricity has its field in the operation of milking machines, refrigerators, sterilizers, barn ventilators and small feed grinders, as well as for electric fences. Poultry raisers are turning in increasing numbers to electricity for incubators, brooders, heaters, water pumps, grinders and refrigerators for eggs and dressed poultry.

In the East some farmers have built small electrically refrigerated apple storage plants. Controlled heating and ventilation of sweet potato storage houses offer another field. Greenhouses find hot-bed, soil-heating cable an advantage, and experiments are well advanced not only for plant growth control by means of electric light, but it is now proposed to build a greenhouse practically without glass, plant growth to be stimulated by

electricity. Within recent years blowers have been used in California as a means of protection against frost.

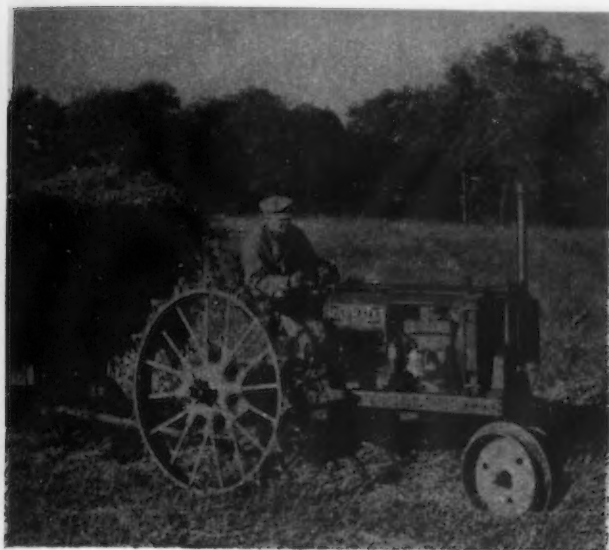
Line costs have been steadily going down, but many experts now think that the minimum has been about reached. Single-phase lines serving about three customers per mile cost about \$1,000 per mile.

In addition to many private and State Government groups working on the farm electrification problem, there is also the work now being done by the Federal Government as represented by the Rural Electrification Administration and the Tennessee Valley Authority. The REA has been established for a 10-year period with a fund of \$410,000,000 for the purpose of making loans for rural lines and purchasing equipment for electric service.

### Irrigation Pumps Electrically Operated

The Edison Electric Institute reports that the 1936 miles of rural lines built by electric light and power companies almost doubled the 1935 mileage, and that the rate of construction reached the average of six to ten years ago. Nearly 100,000 new rural customers are taking electricity from the new lines and about 60,000 new customers took advantage of old lines in 1936.

A new development in the West consists of fifteen 100-hp. electri-



○ ONE-**FLOW**, all-purpose tractor finds wider use (above). Rubber tires, tried successfully on tractors, now find application on other farm equipment (below).



fied irrigation pumps which are converting 10,000 arid acres of the Arizona Farm Products Corp. into fertile farms suitable for raising and harvesting 7-ft. high, long-staple cotton in a single season. Power is supplied by the Salt River Valley Water Users' Association to 100-hp., 3-phase, 440-volt, 1450-r.p.m., 25-cycle, Westinghouse hollow-shaft, vertical-motors driving vertical Pomona turbine pumps equipped with water lubricated rubber bearings. Each pump has a capacity of 2500 g.p.m. delivering a total of 3,600,000 gal. of water and consuming 2004 kw-hr. per day.

Each pumping station is supplied by a simple outdoor 6600/440-volt substation consisting of three 37½-kva. transformers mounted on a concrete foundation, with the necessary outdoor protective devices, safety features, and lightning arrestors. The substations are spaced approximately one-half mile apart and were constructed for approximately \$2,500 each. The wells are 450 ft. deep, 20 in. in diameter, water rising to within 120 ft. of the surface with a total lift of approximately 140 ft.

#### A Study of Farmer's Income

The question of how far the farmer will go in the matter of spending is primarily determined by his income. Much has been said and written on this subject. Somewhat of a new light has been thrown upon it by a report of the National Industrial Conference Board, which shows that in so far as income and purchasing power are concerned, farm operators have not been at an economic disadvantage in relation to other gainfully employed workers in the United States during the normal post-war years. The board's estimates make available farm income figures which are more nearly comparable with estimates of income for workers in other industries than have heretofore been available. These estimates include income from agricultural operations and the substantial additional income which farmers receive for work done off their farms. They also value farm income received in kind at retail prices paid by urban workers instead of at farm prices.

The board also makes available for the first time estimates of net

agricultural income by geographical regions. These show that average farm income for the country as a whole is lowered by the concentration of 54 per cent of all farm operators in the South and

generally low income conditions in that area.

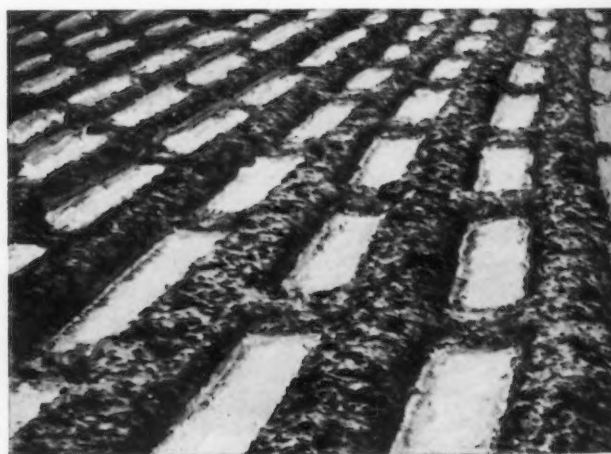
Net occupational farm operator income in 1929, with income in kind valued at retail prices, averaged between \$1,310 and \$1,349. In the



THE basin lister, a moisture conservation prevention of drought

o o o

THE basins made by the machine illustrated erosion



o o o



machine promises to be a great aid in the damage (above).

o o o

retain water and snow and also check surface soil (below).



o o o

same year occupational income of all other gainfully occupied persons ranged between \$1,391 and \$1,397. Therefore, individual farm incomes for the country as a whole, with the South included, were ap-

proximately equal to incomes received in other employment.

In New England and the Pacific Coast States, where part-time farming was prevalent and income from work off the farm was large

in 1929, farm operators enjoyed a distinct income advantage over other workers. In the Mountain States, where large-scale agricultural operations predominate, there was also an advantage for farm operators, though less pronounced. In all other areas there appeared almost no advantage one way or the other. Slightly lower averages are indicated for farm operators in the Middle Atlantic and East North Central regions, and the same or slightly higher averages in the West North Central region and the South.

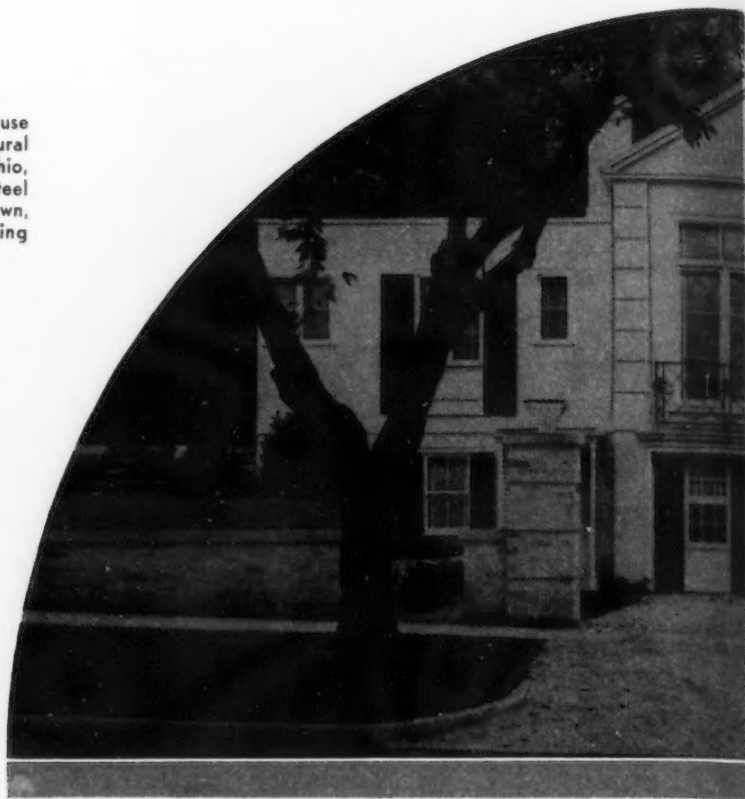
Average net farm income in 1935, excluding Federal Government rental and benefit payments, amounted to between \$873 and \$919 for the country as a whole. This compared with average income of \$1,041 for fully-employed wage-earners, not counting the unemployed, in manufacturing. Average net income of individual farmers was approximately equal to that of manufacturing wage-earners in New England, the Middle Atlantic States, and East North Central States. In the Mountain States and on the Pacific Coast, net farm income was materially higher than wage-earners' income.

### Farmer Spends When He Has It

All told the farmer is, as usual, a good spender when he has average or higher than average income and when he considers that prices are right. He has been experiencing these conditions for over a year and the outlook is that his general status and frame of mind will not change for many months to come.

There are many products of our factories at which he has only been nibbling but he has the taste and his appetite is tremendous. It is quite noticeable that to date the farmer has been putting the largest share of the cash he can spare into production equipment, trucks and automobiles. Once the major part of the above requirements is filled he will turn in a liberal-minded spirit to acquire the appliances and fixtures which are generally considered as those possessions which contribute directly to the American viewpoint of the real standard of living.

° ° °  
**A** FRAMELESS steel house  
 of pleasing architectural  
 design built by Dayton, Ohio,  
 distributor of Insulated Steel  
 Construction Co., Middletown,  
 Ohio; houses of this type taking  
 12 to 15 tons of steel.  
 ° ° °



**E**VERYBODY in his own home  
 —or almost everybody.

If the suggestion appears to be Utopian, it may be replied that it is being given serious study by widespread practical sources. More than that, something is being done about it. Sharing prominently in the move are steel manufacturers. Lying ahead of them is a tremendous potential market for houses to shelter the nation in modern, durable and economic homes. Already technical developments have been achieved and are under way looking to lowering of costs of production that will open the door to a wide demand. Obviously, makers of other building materials are likewise active. They are also reaching out for markets. And each group is making headway. The intensity of the competition has sharpened activities toward supplying the enormous needs. The ideal sought is mass production. This means a truly pre-fabricated house. And the mass production house will not be possible, as pointed out by Harvey Wiley Corbett, New York architect, until its units can be manufactured complete in a factory—complete, including all wiring, switches, all plumbing and all service items, such as stoves, sinks, lighting, curtains and door bells.

Discussing the problem of the pre-fabricated house, Mr. Corbett told the American Institute of the City of New York last November of the technical, economic and political factors that have pre-

vented the mass production of houses. Whereas the cost of assembling a Ford car is only 1 per cent of its price, Mr. Corbett said, the assembling cost of a house is all of 60 per cent. In order to reduce the cost, he added, this item of assembly will have to be eliminated, meaning the end of brick, plaster, lumber, shingles, nails and all sorts of attachments.

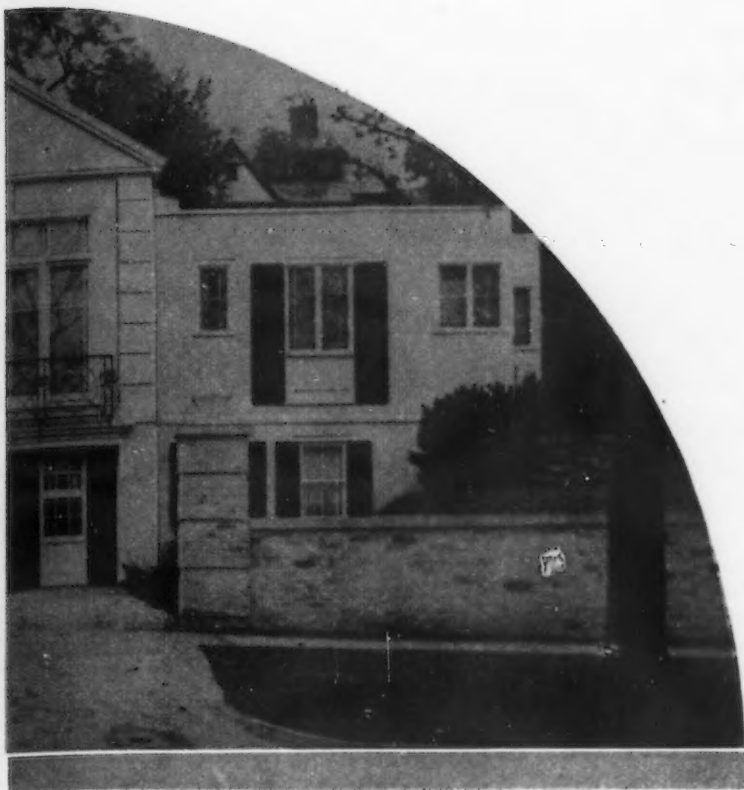
The pre-fabricated house, as visualized by Mr. Corbett, may be far from development—and again it may not be. But it is certain that progress is being made in providing lower cost houses of different types. None uses any single building material. They use a combination of materials, some of them comparatively new in this field. Outstanding in this connection are plastics. As for steel, it is

# HOU

***Tremendous market  
 for dwellings ahead,  
 with steel playing  
 more important part.***

being used in larger quantities, not only for frames but for sidings, staircases, etc., just as steel is making fast headway as material for home equipment.

Responses from 11 steel house builders to THE IRON AGE questionnaire indicate that in 1936 they built about 300 houses. (Some replies did not state the number of



# S I N G

***Steel-frame house  
is making progress,  
though slowly, in  
new building era.***

houses built.) Costs have reached a point where they are equal to wood frame construction when they are built in units, say five or more, and are roundly 3 to 5 per cent greater when single houses are built. Costs of steel houses now range upward from \$3,800 each for the smaller units. Greatly increased demand is expected. One

of the principal changes in type of steel relates to the use of a heavier gage. Some builders who had been using 20 gage material now are using 18 gage. Copper Houses, Inc., New York, has changed from heavy structural shapes to welded frames of 14 and 16 gage hot rolled strip steel. The change from structural shapes to strip steel for frame construction also is a trend. Generally builders of steel houses market them through real estate brokers, who make direct contracts with customers, or through development builders, who handle their own financing. The Stran-Steel Corp., Detroit, reported that through technical developments prices are being substantially reduced. One problem is the rising costs of labor and a shortage of skilled labor. The In-

By L. W. MOFFETT

*Washington Editor, The Iron Age*

sulated Steel Construction Co., Middletown, Ohio, reported that price trends on all types of construction are upward.

One of the recent developments of the Stran-Steel Corp. is the adaptation of Stran-Steel to the low-cost home, ranging from \$3,000 to \$5,000. It was pointed out that this practically means the steel-frame homes can now be built for prices actually competitive with wood. The differential on a \$4,000 home will run only \$100 to \$250 more for steel framing, depending on design. Stran-Steel framing is being used in homes whose cost runs as high as \$100,000, and the company says it feels sure one of these houses in the more expensive bracket is the largest steel-framed house built up to the present time.

Hugh W. Wright, of Steel Buildings, Inc., Middletown, Ohio, pointed out that actual costs of Steelex homes range a shade higher than costs of ordinary frame construction, but that the company's merchandising plan enables it to get the overall cost of the average home to a point where it is competitive with frame construction. He brought out the fact that prices of various types of houses cannot be based on dollars and cents alone. He explained that, considering quality, buyers get far more for their money in buying a steel house than in buying a wood frame house.



**C**OPPER and steel houses being erected at Bethesda, Md., a suburb of Washington, by Copper Houses, Inc. Berloy panels made by Berger Mfg. Co., subsidiary of Republic Steel Corp., are used, each house of this type requiring about three tons of steel.

In order to get wide distribution, Steel Buildings is building up an enlarged and capable dealer organization. It looks for more repeat orders sent in by dealers and also from communities where it has sold steel houses, "for the owners are bound to discuss such matters with their neighbors."

It is Mr. Wright's opinion that next season, if conditions remain good, there will be more activity among industrial workmen.

"This is the volume market for which we are shooting," he said.

In sounding this sentiment, Mr. Wright expressed a growing view of steel makers and others who are actively working toward the objective of seeing "everybody in his own home." It is an objective that is fundamental with President Roosevelt. Government sources are aiming toward its achievement, just as are manufacturers, civic bodies, financial interests, and prominent business organizations. The housing shortage not only is acute and therefore a most important social problem, but from a point of economics it is extremely vital. For, in the opinion of those who are working on it, solution of the problem would bring a well-rounded prosperity. It is held that it would so greatly enlarge markets for materials, labor and capital that production would be brought to a peak and require so much labor as to absorb virtually all the employable. In some quarters it has been estimated actual construction alone would require 9,000,000 workers, with a shortage of skilled labor in the construction

and supplying industries becoming acute unless some remedy is found.

President Roosevelt in a recent message to the convention of the National Association of Real Estate Boards said that he would "not be content until a sound housing program is established for the whole nation," and apparently for the purpose of allaying fears of private interests he added that "there is no need for city, State, or Federal Government aid in connection with housing which private capital can provide." Also at the suggestion of the President, the Business Advisory Council recently accepted for study the problem of living conditions of low-income groups through low-cost housing and slum clearance. The administration is intent upon solution of the problem and, as the President has indicated, it wants private industry to solve it. Nevertheless, intimations have been made that if private industry finds itself to be unable to build houses at prices that the low-income groups can afford—say houses priced at from \$2,000 to \$4,000—the Government will take over part of the job through a system of subsidies or by some other methods. At present it seems likely that continuance of Government aid will apply more to slum clearance than to the higher cost type of building.

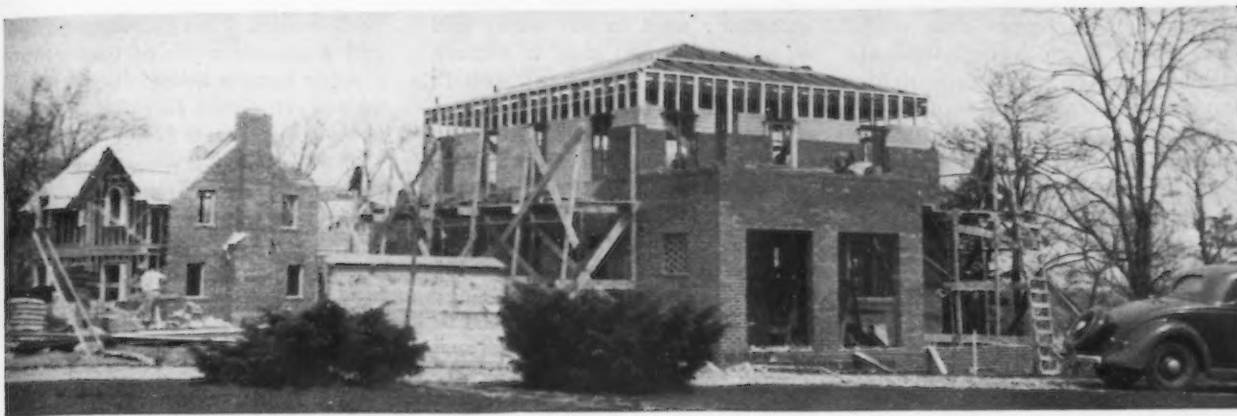
#### **Says 6,000,000 Homes Are Needed**

The immensity of the problem is made clear in a report made by Charles R. Hook, president of the

American Rolling Mill Co., as head of the Committee on Housing and Employment of the National Association of Manufacturers. The report estimated present housing requirements in America up to 6,000,000 home units. This is a large estimate, but when compared with other estimates it is low. The Executive Council of the American Federation of Labor has put the figure at 7,000,000 and has added that, with depreciation and obsolescence, approximately 14,000,000 dwelling units must be provided by 1945 or twice as many as were constructed during the entire "boom" period of 1920-1929. Assuming five tons of steel for a small house of the type now being built it is readily seen that housing offers an enormous potential market for the steel industry. The estimate of five tons per house manifestly is low because some of the houses would be of medium or large sizes and also because of the growing use of steel in housing. Mr. Hook said that a substantial proportion of revival of industrial and business activity and reemployment is dependent upon revival of construction activity. The report pointed out that particular emphasis must be given to low-cost and low-rent housing in the cost range of \$2,000 to \$3,000.

"Our attack," the report said, "must be directed at supplying proper housing for the lower income groups, in providing more and more value at less and less cost."

It urged that it is the duty of the manufacturing industry to lend its aid to development of a pro-



**A** PPLICATION of insulation materials and brick work over steel frame of Berloy house (at left) in Washington. Actual time required to erect steel frames and joists was 144 man-hours at total cost for erection labor of \$58.60.

gram that will quickly start the work of producing the home for the workingman. The situation was pointed to as being an opportunity for opening up an avenue of sound investment of capital with a fair return.

"We must take full advantage of the producing and distributing machinery of the construction industry and add to that all the forces of American ingenuity to solve this problem," the report said.

It was declared that the proper type of service for low-cost housing is now not organized and available.

"We believe it is vital that there should be some organization, whether it be corporate or otherwise, which will focus upon this subject and act as a self-starter and directing agency in following through on this important subject," the committee stated.

It called upon public authorities to do their utmost in reducing the cost of government so that the tax load on the home may be reduced, thereby permitting a higher standard of living. It called upon various producers who make up the construction industry to take advantage of lessons provided by other industries in pursuing further study and research into the manner in which better homes can be provided. The automobile industry was cited for its ingenuity in placing before the people a product at a price within their reach. The committee called upon distributors of products in the construction industry to study means by which they may contribute to lower costs

of homes. It further urged proper cooperation of construction employer and employee to work out plans for more continuous employment, where larger annual returns will be assured to the worker and lower unit costs result. The report deplored Government competition in the normal housing field but asked that the Government continue its function of collation of information.

### The Market for Steel

How fully steel may share in the vast possibilities of the housing program remains to be seen. Development of markets that will justify mass production and therefore lower costs is one necessary element. So is further progress toward the really pre-fabricated house. In this connection one of the important announcements made last year in the housing field was that of the Harnischfeger Corp., Milwaukee, which in April made known its readiness to put on the market a six-room factory-built house to sell at less than \$4,000. This company, in reply to THE IRON AGE questionnaire, said that to its knowledge there is only one other concern which is attempting to market a pre-fabricated house. Development in recent months has enabled the housing division of the Harnischfeger Corp. to standardize its product to such an extent that its officials say they are manufacturing houses on a production basis instead of building homes. The company had built 50 steel houses in 1936 up to Nov. 4.

Government sources look for greater use of steel for housing.

With an increasing trend toward construction of durable homes, it is considered by the Federal Housing Administration, THE IRON AGE was told, more than probable that there will be a steady increase in the use of steel in residential construction during the next 10 years.

The combined influences, moreover, of an admitted need for new housing and replacement of existing structures, it was pointed out, may indicate to the steel industry the possibilities of profit in this field. A continued investigation of new methods of construction by the Housing Administration discloses the fact that many new methods of dwelling construction are being developed and tried out. These methods involve the use of three major materials for the structure of the building—wood, concrete or steel. Steel is being used for frames and in frameless or pan construction. Frames until recently were largely of structural shapes, but the lighter strip steel is now pushing its way forward, both for frames and pans. The reasons for this, it is explained, are that the structural frame of the ordinary residence in addition to carrying floor and roof load, must be a support for an added stiffness and rigidity to interior and exterior finishes which are applied to it. To do this the members must be spaced fairly close together. When even the lightest structural steel shapes are used in this way, a greater weight of steel is used than would be needed if only the load bearing requirements were to be met.

Because of this greater weight, the cost of structural framing is

correspondingly higher than strip steel frames in which the individual members can be made quite light, but so spaced and arranged as to give the requisite strength, stiffness and rigidity. Strip steel members, because they are lighter, can be handled easily by one or two men without any hoisting equipment. The trend is toward larger units fabricated in the plant, so that the work of assembly on the job is reduced to a minimum.

#### Pre-Fabrication Still an Experiment

As the cost of steel for dwelling construction is reduced it finds increasing favor, Federal Housing officials pointed out. Because of its toughness and lightness, they added, it lends itself readily to fabrication, transportation and handling in large panels or units which simplifies the work of field assembly.

It was emphasized by the Housing Administration that it considers pre-fabricated home construction still in the experimental stage.

"Strides have been taken in the field with an idea of reducing construction costs and it is admitted that structural steel has a definite place in the housing field," it was stated. "As many of the homes to be built within the next 10 years will unquestionably be multiple family or apartment buildings and the desire to build fire resistant buildings, the role that steel will play in this development can possibly be very large."

The Housing Administration has prepared an outline that gives an idea of the amount of steel utilized in average home construction.

The following list, while not all-inclusive, gives an idea of the use of steel:

Steel reinforcement in foundation walls and basement floor; steel columns and girders as used in first floor construction; steel basement sash and steel casement windows; steel and cast iron pipe for plumbing; steel-armored conduit for electrical wiring; steel and cast iron heating and air-conditioning plants; steel bathroom and kitchen cabinets; steel lath for plaster and stucco; steel ducts and registers for warm air and air-conditioning systems; cast iron in radiators and steel in radiator shields and covers; steel and iron in stairway construction; steel in fireplace con-

struction; steel in hot water and oil storage tanks; steel in kitchen ranges and refrigerators; steel in hardware for windows, doors, closets, etc.; steel in gutters and downspouts; steel in roof and chimney flashings; steel in window screens; steel for structural connections, nails, bolts, timber connectors, etc.; steel and iron for ventilators and roof surfacing; steel ties for brick veneer added to wood framing.

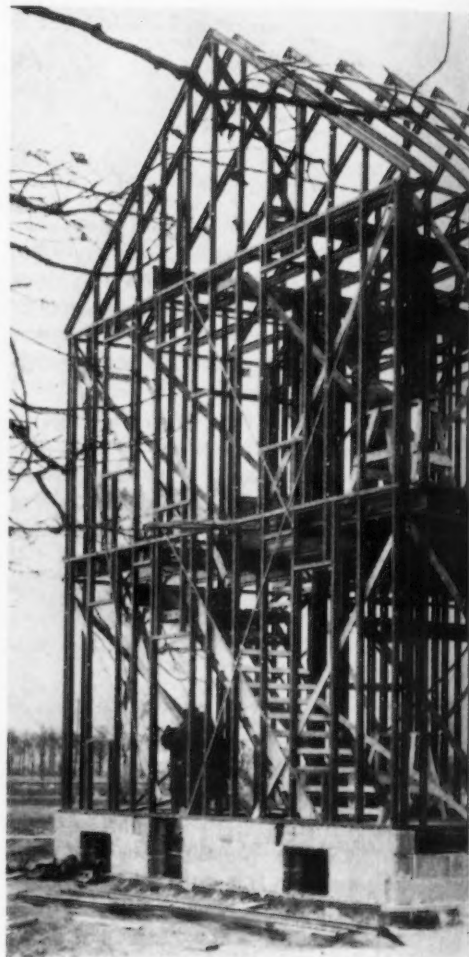
With this wide range in the use of steel in home construction, and the obvious markets for steel in coming and current building activity, the Housing Administration feels that its position gives further impetus to indications of increases in the use of steel.

#### Low-Income Groups Need Program

The FHA does not lend money for home construction. It does provide insurance or mortgages made by private financial institutions for the building of homes. If the terms of the mortgages comply with FHA standards, a qualified borrower may obtain an insured mortgage up to 80 per cent of the total appraised value of the property. In lieu of a 20 per cent cash down payment, land of equivalent value may make up this 20 per cent. The maximum rate of interest is 5 per cent a year. Insurance premium amounts to one-half of 1 per cent of the face of the mortgage, and the lending agency may have a service charge of one-half of 1 per cent. Appraisal fees paid the FHA amount to \$3 per \$1,000, with a minimum of \$10. It is expected that FHA will see a sharp growth in use of its insured mortgaged plan once a housing program is made available to low-income groups. The same, of course, is true as to private investment, mortgage and real estate interests. It has been estimated that 60 to 70 per cent of the American families live on yearly incomes under \$2,500 and that they should be interested in homes costing not more than \$5,000. This is based on the view of economists that one should not pay for his home more than twice his annual income. Only about 7 per cent of the families in the United States are today paying more than \$50 a month in rent or its equivalent. Based upon present incomes, only about 10 per cent could afford a

home costing from \$3,500 to \$4,500 and a great portion of that group already owns a house. But nearly 50 per cent could rightfully own a house costing from \$1,800 to \$3,000.

The goal of that movement clearly is still out of reach, but real progress toward it has been made during the past year. It is being earnestly sought. One builder engaged in a large scale development



near a large city is offering a very complete six-room brick house—slate roof, full basement, excellent construction, complete air conditioning, two bath rooms, modernly equipped kitchen, all on a 60 x 120-ft. lot, improved and landscaped, for \$5,200—10 per cent down and the remainder on a 20-yr. basis at \$45 a month, including everything, taxes and all.

Many somewhat smaller houses, complete and modern in every respect, are available at less than \$4,000. Sponsored by the National Lumber Manufacturers Associa-

tion, three experimental houses in a price range of \$3,520 to \$3,980, with lot, recently were erected in Bethesda, Md., where also steel houses have been built and sold. When the NLMA houses were ready there were 333 applications for them and 63 wanted to pay cash, abundant proof that a market exists. The lower-priced house is a four-room frame cottage. The

tors. And also to prove that private industry merely has scratched the surface of the low-priced home field.

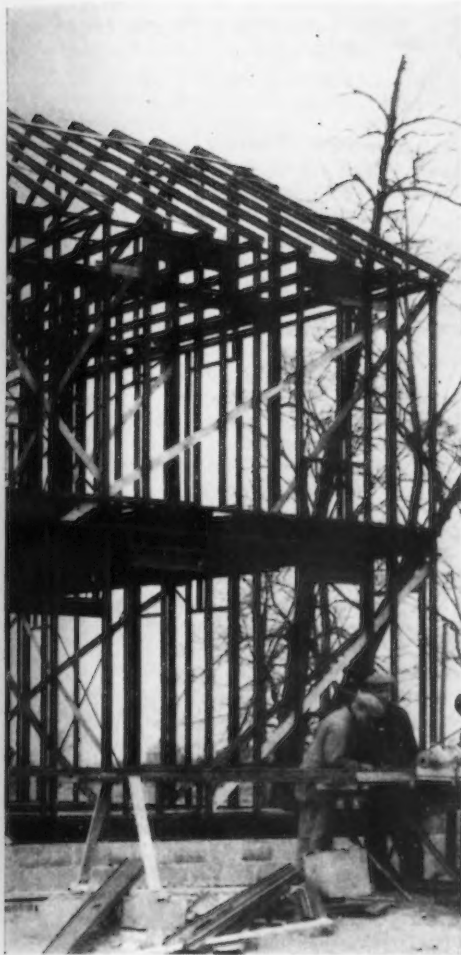
Considerable progress in steel and other houses is also shown in the public attitude toward the so-called "modern" architecture of homes. Ultimately the public may be won over to the notion that beauty can be attained by proper treatment of mass and proportion and color, without the aid of the expensive conventional hipped or gabled roof with its cut-up lines and overhanging eaves. Steel and its alloys have shown striking growth in use for both interior and exterior for utility and for art in houses and in commercial buildings.

It is also true that plastics have made a great stride forward, sometimes used where it is competitive with steel. In an address last October before the Federation of Architects, Engineers, Chemists

and Technicians in Washington, G. M. Kline, chief of Organic Plastics Section of the Bureau of Standards, said that plastics now seem destined to find still wider use in the home and in the building industry in general. In laminated form, he pointed out, these materials are finding important applications, for interior and exterior trim and several new manufacturing units have been organized to meet the growing demand.

#### House at \$2,000 Needed

Manifestly, the greatest hurdle still to be surmounted in the housing field is price. When a small, really modernly equipped, permanently built home goes on the market at around \$2,000 an enormous and entirely new field will be opened. Neither building labor nor the producers of conventional building materials could reasonably oppose shop fabrication and the use of entirely new materials in



#### AT LEFT

**S**TRAN-STEEL house with steel frame under construction by Niver-Parson Corp., Detroit. Houses of this type take three and a half tons for a four-room house up to 65 tons, costs ranging from \$3,800 to \$75,000.

higher-priced house is a two-story four-room house with a dining alcove. The houses are complete, with all the usual conveniences. They have basements, are papered throughout, except for the wood paneled dining alcoves and have heating plants. The prices included a contractor's profit as well.

The NLMA demonstration project was undertaken in response to the suggestion of the FHA to prove that low-priced homes of good construction can be made available today through local building supply dealers and building contrac-

o o o

#### AT RIGHT

**S**TEEL staircase in Berloy house at Canton, Ohio, which can be set in place within a few minutes.



that field. It simply does not exist for them now and cannot possibly be developed and exploited except by complete and efficient shop fabrication—mass production methods.

One obstacle which is quite definitely in the way of both the pre-fabricated house and the low-cost conventional dwelling development is the average city building code. Many of these, in order to guard against "jerry building" and fire hazards, have rigid restrictions prohibiting the use of all but

certain specified, underwriter-approved materials and limiting wall thicknesses, types of plumbing installation, doors, stair construction, floor construction, etc., in such a way that many of the recently developed materials and methods, even though they are entirely comparable from a safety and value standpoint, are at present barred within city limits. Fortunately, it is a matter that is being given consideration by different interests which are seeking a solution to the housing problem.

6. Not enough of factor to consider any changes in competitive prices.

7. Look for gradually increasing demand as people become more familiar with advantages of steel framing, but do not propose to launch any wide campaign of promotion; will be satisfied with very conservative growth which pays its way as it goes.

Comment: Rapid construction of Berloy houses indicated by fact that actual time required to erect steel frames and joists for a house in Washington was 144 hr., or a total cost of only \$58.60 for this erection labor. Another idea used in Berloy system is application of metal staircase to insure fire protection, set in place in few minutes complete with rail and wooden treads.

## STEEL HOUSING PROGRESS IN 1936

### THE QUESTIONNAIRE

1. Number of houses built in 1936?  
Under construction?  
Under contract?
2. What changes, if any, in kind of steel used?
3. Average number of tons of steel used per house?
4. Cost of house, according to size, exclusive of land, to buyer?
5. Method of marketing and terms of sales?
6. What are price trends as related to competitive markets?
7. What is outlook for enlarging demand?

### THE ANSWERS

#### American Houses, Inc., 480 Lexington Avenue, New York

Steel used is largely sheet and strip, with small amount of light rolled sections.

Approximately 5 tons of steel per house at present time. Proposes to use steel more universally for structural purposes as more economical methods for its use in a house are developed.

Houses sold through local dealer organizations.

Confident of constantly enlarging demand for pre-fabricated houses and for use of steel therein.

#### The Arcy Corp., 630 Fifth Avenue, New York

At present (Nov. 2) building seven houses and before the end of the year will probably be building approximately 10 more, all of which will be under direct contract to the Arcy Corp.; all the products manufactured by the United States Steel Corp., including copper bearing sheets, are used in the construction of these homes.

Cannot give the average number of tons of steel because of the wide range in the price of our houses; for example, the \$15,000 house will average 12 tons of steel for the frame and

an additional 3 tons for equipment. Price range will be from \$5,000 to \$15,000 for standard plans and designs and to any price for custom-built houses.

Houses marketed through licensed real estate brokers on a direct contract between the customer and The Arcy Corp. Price trends are in a competitive market with houses built by the better class of builders.

The outlook is rather encouraging due to the fact that Arcy Corp. is not restricted to any particular design and has great flexibility in plans.

#### The Berger Mfg. Co., Canton, Ohio

1. On Nov. 4 had finished one house in 1936, had 10 under construction, to be finished within three weeks and 10 more definitely planned with construction to begin almost immediately.

2. No change in type of construction.

3. Using approximately 4 tons of steel in average small house.

4. No standardized type of house, but flexible system of unit framing. Costs equal to wood frame construction where five or more houses are built at the same time and about 3 to 5 per cent greater when a single house is built.

5. Market material entirely through development builders who handle their own financing in usual way.

#### Copper Houses, Inc., 10 East 40th Street, New York

1. A single large copper house was completed in Watertown, Conn., in the spring of 1936, and 10 houses of a contemplated group of 100 are now (Nov. 11) nearing completion in Bethesda, Md.

2. We have changed from heavy structural steel shapes to welded frames of 14 and 16-gage hot rolled strip steel. These panels are supplied by the Berger Mfg. Co., a subsidiary of Republic Steel Corp.

3. For the small houses which are now being built in Bethesda, approximately 3 tons of steel are being used per house.

4. These houses are being built by a speculative builder, and are being sold in competition with frame and stucco houses of the same size.

5. We are interested, not in individual houses, but in groups of 10 or more similar houses. For a lump sum price, we deliver to the building site the exterior wall panels, which consist of the steel frame, the 1-in. insulation backing board, and the exterior copper sheet as one unit; the interior steel partitions, floor and ceiling joists; and in cases of window panels with the metal windows pre-installed.

6. Built in quantity, copper houses can be sold in competition with inferior frame or stucco constructions.

7. Prospects look very bright for increased demand, judging from the inquiries received from interested home owners, prospective dealers, etc., resulting from the erection of these houses in Bethesda.

#### General Houses, Inc., 620 North Michigan Avenue, Chicago

Either are building, have built, or have orders with \$300 cash deposits in 22 States; have built first modern village of steel houses; setting up dealer organization which already stretches from Marblehead, Mass., to Miami, Fla., and California.

**Harnischfeger Corp.,  
Houses Division,  
6785 West Greenfield Avenue,  
Milwaukee**

1. We have built some 50 houses so far this year.

2. No change is contemplated in our type of construction nor the extent to which steel is used; that is, we will continue to use steel strictly for the framing of floor sections, wall panels, ceiling and roof sections, etc.

3. The weight of steel per house depends entirely upon the size and style of architecture.

4. The price to the purchaser is less than \$5,000. The smaller sizes of houses sell for less than \$4,000.

5. Our houses are marketed through accredited real estate brokers and/or responsible contractors. All houses are financed by local building and loan associations or banks before we proceed with the erection of the house.

6. At the present time there is no such thing as a competitive market in the prefabricated house field. To our knowledge there is only one other concern which is attempting to market a prefabricated house.

7. The outlook for an increased demand is extremely promising.

**Insulated Steel Construction Co.,  
Middletown, Ohio**

1. During 1936, 12 houses of frameless-steel construction were built. At the present time (Nov. 3), five are under construction and three are under contract, with the construction not yet started.

2. No change in the kind of steel used. However, the lightest used at present is 18 gage whereas prior to this year, 20 gage material was used in many places.

3. Extremely difficult to state an average on the weight of steel used in residences. The majority of the residences built and under construction each require from 12 to 15 tons of steel. A number of buildings were constructed using between 25 and 30 tons of steel for each building.

4. Most of the residences constructed have been in the \$5,000 to \$6,000 range although a number in the \$7,000 to \$8,500 range have been built, and an occasional house in the \$25,000 range.

5. Frameless-steel chassis are marketed through distributors who have their own construction organizations to handle not only the erection of the chassis but also the finishing of the buildings.

6. The price trend on all types of construction is upward. To date the upward trend in the cost of buildings constructed of frameless-steel has been less than in other types of construction.

7. The outlook is for considerable increase in demand for buildings of this type of construction. Barring some unforeseen difficulties, 1937 should result in a volume four or five times that of 1936.

Comment: Company states that during 1936, it built 33 commercial buildings of frameless-steel construction; that on Nov. 3 nine were under construction and nine under contract.

**Juul Steel Houses,  
Security National Bank Building,  
Sheboygan, Wis.**

1. Two houses completed. One now under construction (Nov. 3). Three about ready for contracts. Twelve large houses contemplated.

2. No changes made in our type, except some minor details.

3. One small job had 6 tons, two jobs had approximately 14 tons each.

The tonnage included the structural skeleton frame, and wall and floor pressed steel panels.

4. One house, 19,000 cu. ft. at \$4,500 complete; one house, 40,000 cu. ft. at \$12,500 complete; one house, 31,500 cu. ft. at \$10,500 complete.

5. No solicitation work, or sales attempt as yet. All jobs are custom built, for our clients, and contracted for before being built.

Standardizing to come a little later. Method of marketing now receiving consideration.

6. Cost of steel chassis on a par with a wood chassis, besides many advantages of steel construction.

7. The outlook appears very good. The demand can be intensified by keeping the subject before the public.

The total cost of residences can vary either one way or the other, depending on service equipment, etc.

**Steel Buildings, Inc.,  
Middletown, Ohio**

1. During 1936 approximately 100 Steelox homes were built by Steel Buildings, Inc., with an additional 40 under construction at the present time (Nov. 17). We also have, in addition to that, some 15 undelivered orders. Of course, we still have six weeks to go and expect to sell several more orders in that time.

2. The only change in the kind of steel used was to go from 20 gage galvanized to 18 gage galvanized.

3. Steel per house averages approximately five tons.

4. Cost of the house varies greatly even when the same plan is erected in different localities. On the average, prices range from \$2,000 for a three-room modern to \$6,500 for a six-room completely modern home. Specifications are flexible so that the interior finishes may please the owner, and this naturally is reflected in the cost.

5. Under the merchandising plan which Steel Buildings has originated, it is able to get the over-all cost of the average home down to a point where it is competitive with frame construction. Actual costs range a shade higher than ordinary frame construction but "when the increased quality is taken into consideration the

buyer gets far more for his money than he does at the present time."

6. 1936 was the first opportunity to sell any quantity of homes as the market was absolutely dormant previously. Experience this season has been very encouraging. Have been able to sell a slightly higher price range than originally anticipated, but believe the reason for this is that it has been the so-called white collar class who enjoyed a more stable income who are responsible for most of the building activity. Next season, if conditions remain good, should see more activity among the industrial workmen. This is the volume market for which company is shooting.

Another encouraging factor is the number of repeat orders which the dealers have sent in; look for still more repeat business in the different communities where we sold houses this year.

**Stran-Steel Corp.,  
6100 McGraw Avenue,  
Detroit**

1. The first nine months of this year (1936) show an increase of 68 per cent over a similar period last year (1935).

2. The same welded 16 gage strip steel members now are partially prefabricated into wall panel frames. All studs, joists and rafters are nailable and the panels are designed to fit any house plan.

3. 3½ tons for a four-room house up to 65 tons.

4. Houses have cost owners \$3,800 to \$75,000. Stran-Steel framing usually increases the cost of a moderately priced home 4 or 5 per cent.

5. Stran-Steel does not build houses but furnishes framing material through a network of dealers and branch offices.

6. Through technical developments, prices are being substantially reduced.

7. The reception recorded Stran-Steel in new territories opened indicates a considerable increase in the proportion of houses using steel framing.

**Kelvinator Corp.,  
Detroit**

1. Number of houses built in 1936: 75 built in the Detroit area.

2. Kind of steel used:

1 Stran-Steel house. The remainder just steel beam in the basement and lintel steel.

3. Tons per house:

¾ ton of steel in a normal house.

4. Cost of house:

\$7,500.

5. Methods of marketing:

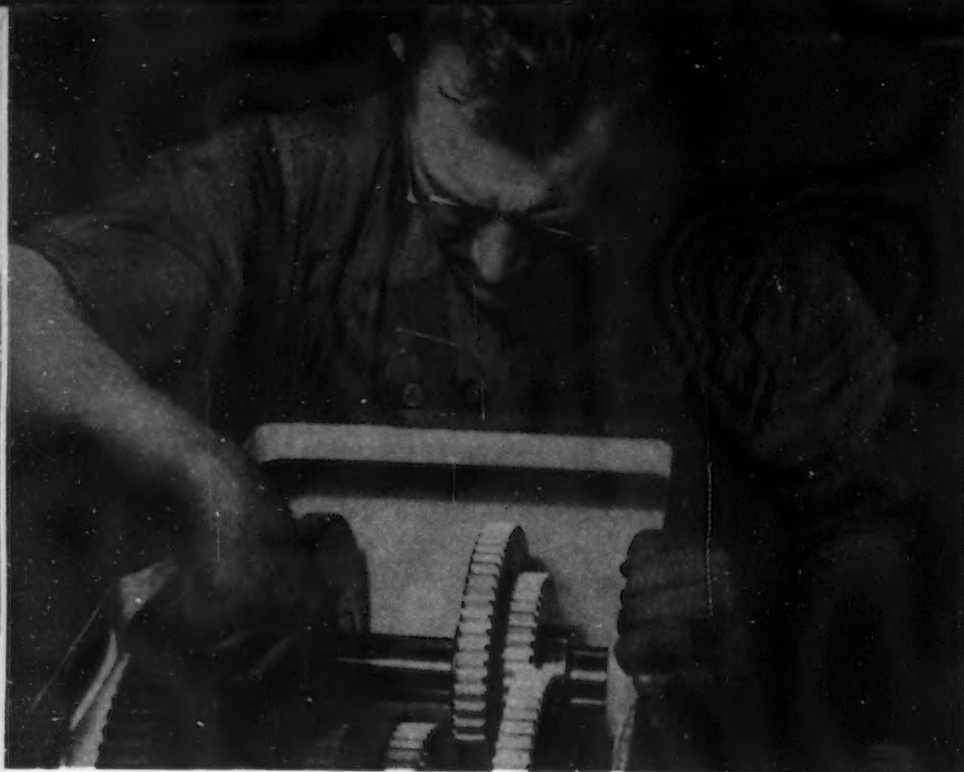
Real estate, sales organizations 20 per cent down, balance FHA and HOLC mortgages.

6. Price trend:

Upward.

7. Outlook:

Very good.



# MACH

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"THE leaders of this (National Machine Tool Builders') Association did not wait for more favorable conditions. They set out to create favorable conditions through their own efforts, thus displaying that courage which should be typical of American business endeavors."

Such was the tribute paid to the machine tool industry by Secretary of Commerce Daniel C. Roper in May, 1936, when he presented to the National Machine Tool Builders' Association the American Trade Executives' Award for "—the outstanding achievement by a trade association during the last three years." That achievement was the staging of the Machine Tool Show at Cleveland in the fall of 1935. Thus has that venture — conceived and

planned in the darkness of the depression and carried out during a period of continued political, economic and industrial uncertainty—been written down in history as one of the definitely successful major moves toward business recovery.

Immediately following that 1935 show came a brief lull in the machine tool business. It now is realized that it was due to the fact that executives and production men throughout the machine tool using industries momentarily were stunned by their sudden realization of the sweeping extent to which their plant equipment had been rendered obsolete by the revolutionary 1930-1935 machine tool developments as unveiled at Cleveland. They had gone to Cleveland expecting that here and there they would see a new machine with which they could patch up their production departments and tool rooms, thereby bringing them quite up-to-the-minute. They left Cleveland realizing that such patchwork reequipment schedules

would immediately have to be redrawn on an entirely different and much broader basis.

By the beginning of 1936 these redrawn reequipment schedules began to go into effect, releasing a rising tide of machine tool business which—starting at the theoretical 100 per cent based on the average monthly shipments in 1926—has pushed steadily upward throughout the year through a point about 40 per cent above that level. And still it mounts, with the 180 per cent record of 1929 not beyond the bounds of imagination.

## New Tools Beget More New Tools

Orders generate more orders, as the more conservative manufacturers are forced by reequipment of their competitors to reequip themselves, or fall by the wayside in the keenly competitive race of mass production. Then again, those who moved cautiously, putting in only a few of the latest machines, have found their plants as full of "bottlenecks" to the flow of production as there are

# MACHINE TOOLS

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*The industry is now reaping  
the reward of courageous de-  
velopment and improvement  
throughout the depression*

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outdated machines being "paced" by the new ones. Good workmen, scarce in the metalworking industries for the first time in six years, are doubly hard to get in shops equipped with machines of another day and age.

Beyond all this is consumer pressure for reequipment through demands for finer and cheaper automobiles and vacuum cleaners and washing machines and refrigerators and other things too numerous to mention. Little does the average "man in the street" realize that a small group of geniuses within the machine tool industry, working and planning on through the dark days of 1932 and 1933 and 1934, actually was devising the means through which his 1937 automobile has become available to him.

Our man in the street and untold thousands like him may not have the slightest conception of what a machine tool is, but through his enthusiastic acceptance of the kind of mechanical products that only the newest ma-

chine tools can produce economically, he (the public) is after all the big power in forcing up machine tool sales.

We hear but little now about enforced limitations of mechanical equipment, the threat of which hung heavily over the machine tool industry not so long ago. That false issue has been killed by recovery. All signs point to an imminent scarcity of equipment comparable to or even more serious than the already existing scarcity of skilled mechanics.

## **Rebuilding an Industry**

What of the machine tool industry in these days of recovery? Having carried out their great program of design development during the years of the depression, are not the machine tool builders now able to tilt back in their chairs and watch the dollars again come rolling in? The answer to this most emphatically is, "No!" The machine tool industry, squeezed dry of cash and of personnel by the depression, literally

has had to rebuild itself from the bottom, and this rebuilding process still is actively under way.

When recovery began, the average machine tool company found itself with a plant of uncertain vintage which its own engineering activities as well as those of the other machine tool builders had rendered quite thoroughly obsolete; with rather acute shortage of cash but with unblemished credit; with a skeleton organization consisting primarily of executives and engineers, and a few key men of the shop; with sweeping new designs (mostly on paper), and with an amount of faith in the industrial future of America which was surprising in view of what the depression had done to the business and what certain governmental experimentalists were threatening to do to it.

Scattered to the four winds were most of the toolmakers, machinists, patternmakers, foundrymen, heat treaters, detail draftsmen, the office force, salesmen,

demonstrators and the sales promotion staff. In the years since the great industrial demobilization following the economic crash of 1929, death has taken its full toll of the reserve of workers; age, lack of practice and physical and mental decay incident to the depression robbed many others of their skill of hand and keenness of mind.

Still others, dismayed by the depths to which the machine tool business plunged, sought social security in other avocations such as management of filling stations, taverns and chain stores, manufacture and sale of doughnuts, and in the widened realm of Government service. In the meantime, few if any were being trained in the industry. For several years there had been no apprentices, no learners, no student draftsmen. In other words, a wide gap had developed in an industrial generation.

Then came 1936, with its problems of the physical rehabilitation of the machine tool industry to cope with a rising tide of business in many ways unparalleled in peacetimes.

Office and sales staffs immediately had to be built up and trained to take care of the inquiries and orders which began to pile up. Draftsmen had to be found or "broken in" to complete the development of new designs, jigs and fixtures to cover completely the wide range of sizes and models that characterize machine tool lines. Former mechanics and tool makers and other shopmen—such as still were available—were called back and retrained to build new machines and tools of quality higher than anything that they had ever before undertaken.

Apprenticeship and other training systems had to be reestablished, but there was not time to wait for the completion of full training courses. Quick methods had to be developed whereby young men, most of them wholly unfamiliar with machine shop practice, could be given limited skill on certain operations, thus becoming immediately useful while continuing to learn the trade in its broader aspects.

In machine tool centers, such as Cleveland and Cincinnati good use is being made of trade schools in this quick development of talent and skill to make up for the "lost

generation" of machine tool craftsmen. It is a sign of the times that the high technical schools are being combed for engineering talent to serve an industry which not so many years ago practiced a good deal of rule-of-thumb engineering.

It is noticeable that the "cloistered" type of machine tool designer—that anemic person with green eye shade and black sateen coat who worked in constant fear both of the shop and the "front office"—has been replaced by a more virile type, one who has been places and seen things in industry. This is in line with a talk made before a group of machine tool builders about 10 years ago by an outspoken critic of the industry.

That man said: "If you wanted your designers to become infected with the virus of typhoid fever, you might send them to a place where they would be bitten by typhoid bearing mosquitoes. If you want your designers to become inoculated with some real production ideas, why don't you stake them to a trip to Detroit where the production bugs will bite them?"

#### Jigs, Fixtures and Special Tools

Jigs, fixtures and special tools represent another big engineering problem, and a comparatively new major problem to some machine tool builders. The jigs and fixtures used today in progressive machine tool plants rival in ingenuity and out rival in accuracy those used in the larger mass production industries. While they are of course of great help even in the relatively small production of machine tools (lots of 10, 20, 50 or possibly 100 units usually are dealt with in this industry), their primary purpose is to insure interchangeable repair parts to users. When a key machine is down in an automobile plant, the repair part—ordered by wire and shipped out of stock by air express—must slip into place without fitting. If it does not, that machine is promptly and unceremoniously yanked out of the production line and with it vanishes its builder's prospects for further business in that plant.

In machine tool design the novelties and noble experiments of ten or even of five years ago not only are acceptable to but are demanded by machine tool users today. Some of these, named at random are: Cemented carbide tools; hydraulic

actuation; pneumatic devices; power chucking (electric, hydraulic, air and mechanical); centralized control (electric, hydraulic, air and mechanical); anti-friction bearings, including preloaded spindle bearings; alloy steel spindles, shafts, gears, cams, etc.; special alloy iron castings and some welded details (already discussed); built-in automatic lubrication and coolant systems; hardened steel ways and tool slides; hardened, ground and lapped gears and worms of the most advanced tooth forms; unit construction; independent drive to units; and specialized built-in electrical systems.

#### Electrical Developments

For a long time it has been evident that the machine tool industry and the electrical industry did not fully understand each other. The electrical industry did not know exactly what the machine tool industry required in the way of electrical equipment nor did the machine tool industry have a complete understanding of the ways and means and available equipment for effective and dependable electrification. Neither were the full possibilities of electrification fully appreciated.

It was a flash of inspiration when R. S. Elberty and others at the Westinghouse Electric & Mfg. Co. conceived the idea of holding at East Pittsburgh the Machine Tool Electrification Forum, June 22-25, 1936. Response of the machine tool industry to this invitation was highly gratifying, more than 50 engineering and other executives from leading machine tool companies attending this industrial "clinic."

It was a give and take proposition, the electrical group learning for instance that standard electrical equipment leaves something to be desired by machine tool builders, both in appearance (finish) and in tolerance on vital dimensions (bottom of feet to center of shaft, for example). The machine tool men at the same time got some new ideas on electrical control, on the possibilities of gear-motors, on the motorizing of individual motions, and on the possibilities of electrical instrumentation of machine tools.

As he looks for a moment into the future, the writer of this review sees electrical instrumentation of machine tools as one of the significant things to come, with

production equipment carrying neatly built-in instrument panels on which can be read at a glance speeds, feeds, tool pressures, load on motors, and any other vital values affecting production and tool life.

In addition to this demonstrated willingness on the part of machine tool builders to take advantage of the higher types of engineering during 1936, another very hopeful sign has been their unusual activity in reequipping their own plants with the latest machine tools.

In passing it should be noted that 1936 saw the first construc-

tion of plant additions of any size in the machine tool industry since 1929. A number of such additions were built, especially to assembly department, and several other companies now are contemplating additions. In a number of instances air conditioning is a live issue. So exacting have measurements become in the machine tool industry that constant temperature is desirable, as also is filtered air, which would keep floating grit out of precision bearings, etc., in the course of assembly.

Sales promotion and advertising, after lying dormant for about five years, has taken a new lease on

life in the machine tool industry. "Styling" of machine tools in some cases—that of the Ex-Cell-O Aircraft & Tool Corp. being one—has recently been carried out by professional industrial stylists of national repute.

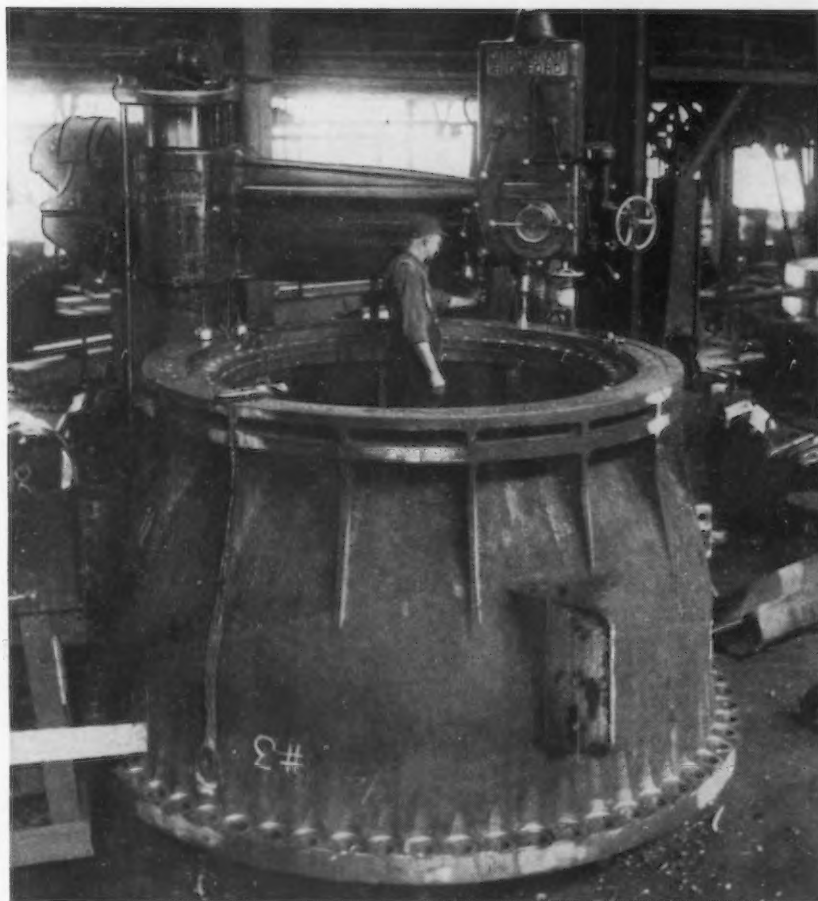
All of these things that have been so briefly touched upon in this review of the industry indicate a new spirit of vitality throughout the American machine tool building realm. Great progress for industry as a whole and for our country is undoubtedly foreshadowed by the quickening that has taken place among the makers of our master tools.



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**T**APPING the 56 2/4-in. stud holes in the nozzle section of one of the 72-in. 60-ton needle valves built by the Thomas Spacing Machine Co., Pittsburgh, for installation at Boulder Dam. A total of 176 holes is drilled in the parts for each valve. The machine shown is also employed for counterboring and spot facing of the flange bolts. Other operations were described and illustrated in *THE IRON AGE* of July 30, page 32.

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# STEEL

° ° °

By F. L. PRENTISS

*Cleveland Resident Editor,  
The Iron Age*

° ° °



THE expansion in the demand for finished steel that came with the industrial recovery in 1936 brought with it increased use of special steels, particularly the low alloy, high tensile steels that had been introduced during the previous year or two, and more extensive use of stainless steel than in any previous year.

Metallurgical laboratories of steel companies were kept busy during the depression days developing new and improved steels and, with the broadening of the steel market last year, consumers had their selection of a wide variety of special steels possessing increased strength, corrosion, heat and abrasive resistance and other improved qualities as compared with plain carbon steels.

Additions to the lists of new special steels were not numerous last year, but a broadened market developed for these steels in new applications and in uses for which they had previously been adopted in a rather limited way.

Expansion of steel business last year was due to the increase in production of nearly all lines of products made of steel, although

# USES GROW

*Increased demand for special steels, including high tensile grades and stainless, featured 1936 business; many new applications for lighter products*

the heavy equipment field lagged behind most others. Private building work as well as revamping of commercial structures took a sharp upward trend, which aside from stimulating demand for steel in other forms resulted in a large increase in the use of porcelain enameled steel for store fronts as well as for stainless steel for trim for the porcelain enamel panels and for store signs.

## **High Tensile Steels Make Headway**

Use of low alloy, high tensile steels became more diversified and experienced a substantial growth the past year, particularly in the transportation field. First introduced in the railroad field as a material for freight and passenger car construction, these steels, now made in about a dozen steel plants, have won much favor among manufacturers of motor trucks and other types of transportation equipment because their high strength, light weight and resistance to corrosion make them superior to plain carbon steels. Manufacturers and users of motor trucks and trailers have come to appreciate the advantage of lighter construction and larger pay loads. In fact, these steels are finding a broader market in almost every field where a combination of high strength and light weight is desirable.

High tensile steels are still in their development period in respect

to applications. While they have not yet become a high tonnage product with producers, their use is constantly expanding.

Railroads are more generally adopting the use of low alloy steel for important structural parts of passenger cars in order to reduce weight. This reduction amounted to 30,000 lb. per car in two passenger coaches of all welded steel construction, recently rebuilt by the St. Louis-San Francisco Railroad.

The high tensile steels in sheet form have been used in the construction of many gas and fuel oil tanks for trucks and considerable of this steel is now being used in fabricating truck frames. There is also a trend towards the use of this steel for fabricating side rails, frames and chassis for other types of trucks.

In the commercial car field, bodies of delivery trucks are now being made of light gage cold rolled, high tensile strength steel, resulting in a saving in some cases of more than 600 lb. because of the use of the lighter gage and providing trucks that are more attractive in appearance. Stainless steel trim is also used to make the trucks more eye appealing.

One of the more recent applications of low alloy steels is in the oil industry where its use in the form of seamless drill pipe, casing, tubing and sucker rods is still in the development stage. For oil well

material it has the advantage of corrosion resistance as well as strength.

A recent application of high tensile steel is for the manufacture of clamshell buckets for handling coal and ore, thus increasing the pay load and providing buckets with much greater resistance to corrosion than plain carbon steel.

## **Use in Dwellings Gaining**

Use of steel in various forms in the construction of residences is constantly growing. The air conditioning industry has made rapid strides, particularly noticeable in the increase of air conditioning equipment in residences and this growth has created a marked increase in the demand for sheet steel for air conditioning installations.

## **Timken Introduces New Steel**

Two new groups of steels were brought out by Timken Steel & Tube Co., Canton, Ohio, during the past year. The more recent series, which are for high temperature service, are high silicon steels known as Sicromo 1-2-3 and 5, the numbers indicating the mean percentage of chromium present. They all contain 0.050 per cent molybdenum. Sicromo 1-2-3 is recommended for low to medium oxidation and corrosion resistance and No. 5 for use for resisting severe corrosion and oxidation.

The other new Timken product, which is designated as Silmo steel,

was developed for making tubing where a steel of high temperature strength and greater resistance to corrosion is required than is available in carbon steel but is more economical than the high price alloy steel.

#### New Armco Galvanized Sheet

A galvanized sheet with a new kind of finish to assure a good paint bond without special treatment of the surface was brought out late in the year by the American Rolling Mill Co. These sheets, which are designated as "Armco Galvanized Paintgrip" sheets, are chemically treated to produce a finely crystalline phosphate coating which is neutral to paint, being neither acid nor alkaline, and which keeps the paint from direct contact with the zinc surface.

A new high tensile steel being designated as H.T.-50, having low carbon content, strength being obtained by other additions, is another new Armco product. The yield point of this steel is given as 47,000 lb. per sq. in., its tensile strength 67,000 lb. and its elongation in 2 in. is 28 per cent in hot-rolled grades. Tests have shown an impact tensile strength of 5000 ft. lb. per sq. in., or nearly double that of mild steel. This new steel is said to have four to six times the corrosion resistance of plain carbon steel.

Asbestos bonded corrugated pipe is another new product that has been developed by Armco as an improvement in the paved invert type that has a bituminous pavement in the bottom.

A new product for use in the building construction field is a steel stud for the steel frame construction of a residence or other light load structure. This stud, recently introduced by the Bethlehem Steel Co., is a light weight, lattice web, one-piece member with a minimum steel thickness of  $\frac{1}{8}$  in. The studs may be used for supporting walls or in conjunction with steel joists for the construction of a complete framework of steel.

Cold rolled strip steel in colors designated as "colorstrip" is a new product of the Acme Steel Co., Chicago. This, made in 0.050 gage and in 8-in. widths and finished in various colors, is designed for automobile and other moldings, bottle caps and various other products.

A new line of steel shingles made of galvanized sheets was brought out late in the year by the Gulf States Steel Co. These are made to overlap each other on all sides, thus covering the nails by which they are fastened.

#### Dams Call for New Piling

Demand for abrasive resisting steels has grown, much of the increase being brought out by Government dredging operations in connection with inland waterways.

A new type of integral rolled Z sheet steel piling was a new product of the Carnegie-Illinois Steel Corp. the past year. The Z-shaped section was selected because this shape has the highest beam strength for its weight and because the interlocks are located where the longitudinal shear is zero.

Hence the section modulus of the single interlocked pile is the same as when interlocked with the adjoining pile. Demands for piling having increased beam strength, it is stated, have resulted from its more extensive application for heavier lateral loads and longer spans.

The use of bearing piles is growing quite rapidly and provides an outlet for a substantial tonnage of steel.

The use of steel flooring for bridges and in lighter section or in some combination of steel in flooring for residences is rapidly being extended.

A heavy-duty bridge deck of cellular construction was brought



ABOVE

**A**N automatic water heater, built of steel, one of the new domestic devices.

o o o

AT LEFT

**A**NEW type steel kitchenette, designed and built by General Electric Co.



out by the H. H. Robinson Co., Pittsburgh.

New products for use in paving, which have been introduced, included a new type of paving plates made of rolled steel offered by the Bethlehem Steel Co. and cast iron paving blocks brought out by the Interlake Iron Corp. The Wheeling Corp. provided a new use for steel in a dowel and joint support



ABOVE  
**A** WESTINGHOUSE roaster, illustrating one of the many new domestic uses for steel.

o o o

AT LEFT  
**D**UE to low power rates, electric stoves provide another steel outlet.

for expansion and contraction joints in concrete pavements.

#### More Steel in Automobiles

The amount of steel required in the manufacture of 1937 automobile models has materially increased because of the changes in body construction as well as through the wider adoption of steel tops. In the so-called Unisteel body construction, adopted by the General Motors Corp. for the steel interior bracing and U-shaped roof rails and cross members under the floor a gain of 35 per cent in consumption of body sheets by the Fisher Body Division of General Motors is expected this year even if there is no increase in the number of units built. This will bring the total sheet consumption of General Motors this year up to 600,000 tons for building the same number of bodies that were constructed last year.

Manufacturers of the newest member of the family of passenger vehicles, trailer coaches, are providing an outlet for a considerable tonnage of steel which is growing larger because trailer manufacturers are trending toward all steel construction in place of wood and because of the rapid increase in house trailer production. Several of the new 1937 models of trailers have steel body framing and steel chassis.

#### Tubing Uses Widen

Use of mechanical tubing is increasing, particularly in the transportation field, round tubing being used for seat frames for railroad cars and buses and square tubing for frames for house trailers. In addition, the square tubing has been adopted for making the entire frame of the Garwood bus. Other bus manufacturers are using it for frames in an experimental way.

There is a decided trend toward the use of square tubing for construction of artistic chairs and other furniture, although its higher cost as compared with round tubing is tending to restrict the increase in its use.

A broadening use of galvanized sheets is reported in the motor truck field. These sheets are being used in the manufacture of trailer bodies and milk trucks, and in some cases for roofs for truck trailers, this steel being found well suitable for this construction work because it can be shot welded and because it furnishes good surface for the adhesion of paint.

#### Stainless Steel Consumption Gains

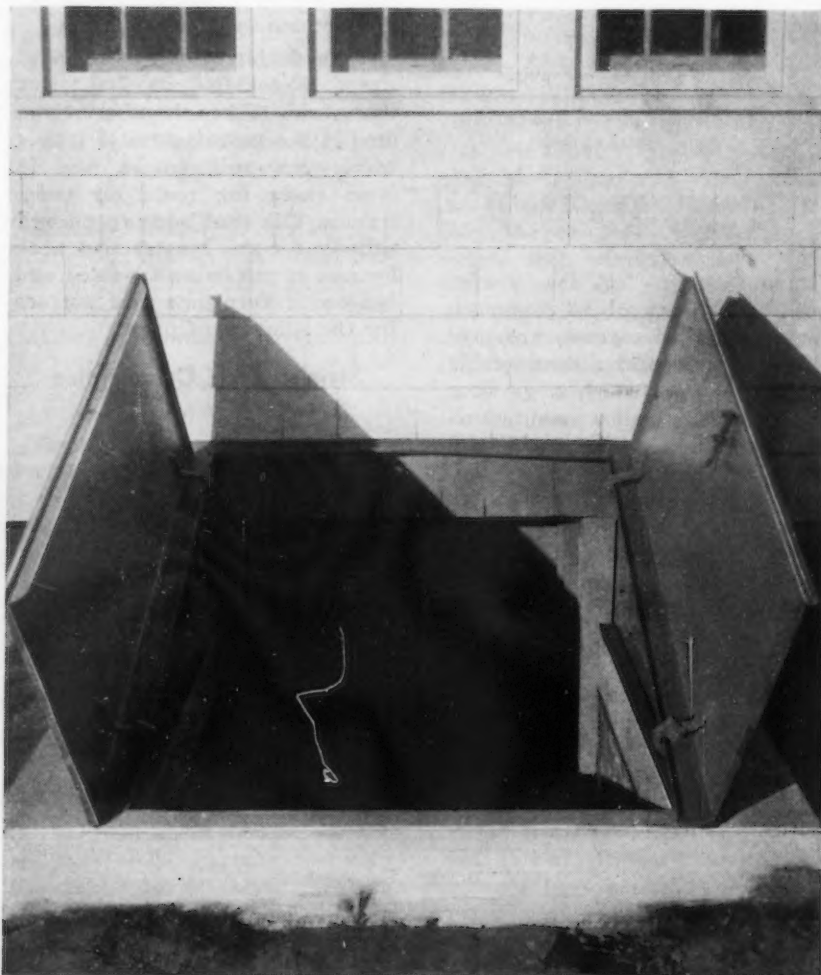
Stainless steel made considerable headway in the quantity used during 1936 and promises to make further advances this year. The larger tonnage used last year was due largely to more extensive applications in industries that heretofore had used stainless steel rather than any outstanding new applications. However, numerous new uses were developed.

The textile industry is outstanding in turning to stainless steel in a large way during the past year, and the demand from this field has increased sharply. The stainless material is rapidly replacing wood and has become a strong competitor of some other metals for vats for dyeing and bleaching and other



ALL stainless steel cafeteria in the plant of Armour & Co., Chicago.    o    o    o

o    o    o    ONCE built entirely of wood, this hatchway to cellar entrance is now furnished in steel.



equipment used in the wool, cotton, silk and rayon industries where resistance to corrosion, contamination of products, heat resistance and cleanliness present serious problems.

Food and dairy industries consumed increasing amounts of stainless steel during the past year. The packing industry has adopted the stainless steel for various equipment such as packing and cutting tables, conveyor belts, cookers, viscera tables and meat hooks. Dispensers for serving various fruit juices are to have tops of stainless steel because this material is easy to keep clean and neat in appearance.

The automotive industry has used approximately 50 per cent more stainless steel the past year than in any previous year, according to a recent survey. One of the largest single uses, the radiator grille assembly of a popular low priced car, alone requires from 7500 to 10,000 lb. of stainless steel daily, the straight chrome type being used. With modern production methods it is stated that stainless moldings can be produced more economically than chrome plate moldings and as a result the stainless material has been adopted as a standard for moldings by most of the automobile manufacturers. Stainless steel is also being used for automobile headlights, hub caps, hardware, lock covers for

spare tires, trim on louvers and other parts in automobile construction.

### Many New Uses for Stainless

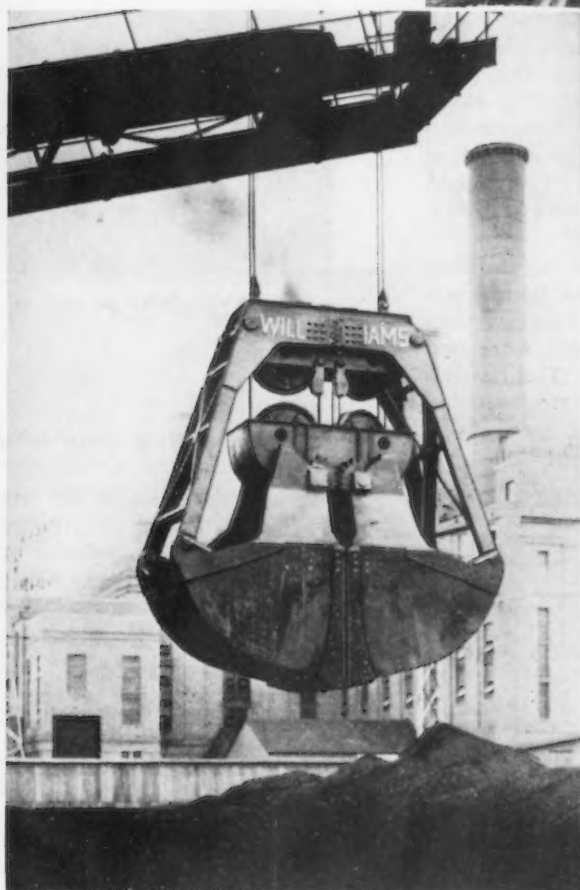
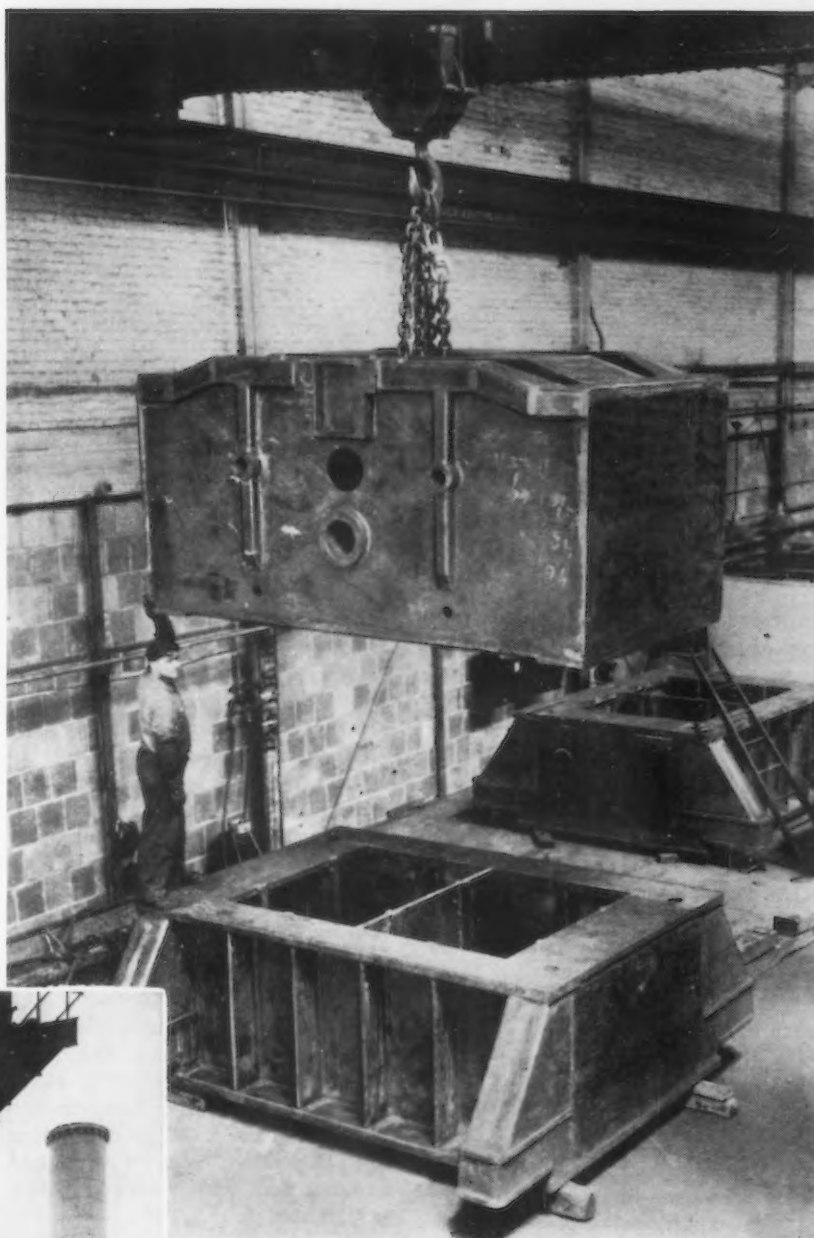
Among new uses for stainless steel is communion cups. Most of the glass cups used in this country are imported from England.

The stainless material is going into parts for washing machines, gas filling machines, springs, bolts and nuts and numerous other small parts. The housewife can now buy stainless steel wool, which can be used longer than the ordinary steel wool because it will not rust. Dry cleaners are now using pads made of stainless steel for pressing coats.

Fairly large tonnages of straight chrome stainless steel are being used by makers of copper and brass products for annealing trays and pans.

Railroads have continued to use stainless steel in passenger train construction. This steel is being used in building two new 12-car trains for the Burlington Railroad and for 48 cars for making up six or eight trains for the Santa Fe.

Tableware of stainless steel



ABOVE  
**A** LARGE arc-welded steel press in process of assembly at plant of Taylor-Winfield Mfg. Co., McKees Rocks, Pa.

LEFT  
**C** OAL handling bucket made of high tensile steel.

gained in popularity the use the past year. Knives, forks and spoons and also service plates and trays of the stainless material designed along most attractive modern lines were brought out by makers of flat ware.

Sales of kitchen utensils of stainless steel have increased sharply during the past few months and the use of the stainless material for kitchen cabinets, sinks, and other equipment has steadily gained.

Stove manufacturers are using stainless steel in considerably increased quantities for tops and trim of table top gas stoves.

Stainless steel window sills have



**A** TRUCK tank of high tensile steel fabricated by Davis Welding Co., Cincinnati.

provided a new application for the use of this material.

Stainless steel is going into builders' hardware in increasing quantities. Advantages of its use were brought out forcibly by the flood in the Pittsburgh district last spring. Hardware on first floors was corroded and ruined and fixtures were warped and twisted. Kick plates and push plates in the main floor of one of the leading buildings were replaced with stainless steel and it is announced that the entire building will be equipped with hardware of stainless.

Stainless steel was used last year in the construction of an airplane, the first to be built of that material for commercial purposes, although stainless steel had previously been used in the construction of two experimental planes. The new stainless steel commercial plane is a four-passenger streamlined cabin amphibian, which is built almost entirely of stainless steel, except the engine, wing fabric, control surface coverings and minor parts. In its construction 1600 lb. of stainless steel was used.

Steel manufacturers have added to their line of stainless steels by bringing out material in various new types and analyses. A new type of stainless steel designated as Enduro 18-8-SMo is being used more generally in the textile industry and for the manufacture of paper and pulp mill equipment. This is similar in physical characteristics to the regular 18-8 but has additional corrosion resistance imparted mainly by the addition of 2 to 4 per cent molybdenum. This type is being substituted for dye

tanks made of wood, glass and non-ferrous metals.

A new stainless steel, the use of which was adopted by some aircraft manufacturers during the past year and which is said to increase the safety factor, and contribute its share in permitting the construction of airplanes for operation at still higher speeds has an addition of columbium. A decided advantage is claimed for columbium over titanium as an added element to prevent the precipitation of carbides at the grain boundaries and thus eliminate the susceptibility to intergranular corrosion which has limited the use of stainless steels within certain high temperature ranges. This steel is now being used in aircraft collector rings and exhaust manifolds where vibration is a factor.

Another new type of stainless steel, one with rather limited application, was developed particularly for making table ware and other spun products. This has less tendency to harden during spinning than the regular 18-8 type, and is designated as Enduro 18-8-FS. While the tendency to harden during cold working is not eliminated with the use of this steel, it is claimed to be materially reduced so that fewer annealing operations are required.

New uses for sheet steel have been provided by the joining of the steel to a wood veneer which serves as a facing and also by the joining of steel to a backing material, the sheet in that case serving as a facing. A product with a facing of thin wood veneer over steel designated as Steelwood and another

product with a facing of thin sheet steel glued to plywood and known as Plymetl were brought out recently by the Haskelite Mfg. Corp., Chicago.

The use of porcelain enameled steel expanded sharply during 1936, the growth being more conspicuous in the architectural field than in other directions. The popularity of porcelain enameled steel as a colorful and decorative material for store and theater fronts, gas filling stations and lunch diners resulted in a very large increase in the demand for enameled building material that has taxed the



**W**ELDERS at work on a truck Co.

capacity of enameling shops doing that class of work.

With the development of new pressed steel enameled products and the increased popularity of porcelain enameled household equipment, the use of porcelain enamel steel in the home also expanded during the year. The pressed steel bath tub is one of the more recent products and promises to furnish a market for a large tonnage of sheets. These tubs are now being made by at least four manufacturers. The pressed steel lavatory is another

new product in the home plumbing field and the market for this is said to be growing rapidly. Toilet and shower stalls of porcelain enamel are new products that were recently introduced. The use of steel in the kitchen for cabinets, sinks and other conveniences is growing and considerable of this equipment is porcelain enameled.

Newspaper sales stands of porcelain enamel steel were recently introduced.

Many new products for the home, including electrical and other appliances, providing additional

erator, all electrically operated, and various cabinets.

A recent Westinghouse product is a rectangular roaster in modernistic design. The metal parts of this utensil have three finishes. The exterior of the stamped body part is black baked on enamel with chrome plated trim. The cover is chrome plated and the inset is finished in porcelain enamel.

A hatchway to enclose the outdoor entrance to the basement of a residence is a new steel product that has been brought out by the Bilco Mfg. Co., New Haven, Conn. This is designed to displace the commonly used wood hatchway.

New products of a miscellaneous character, largely for the home, and made of steel are being brought out constantly and consume a great deal of steel usually purchased in small lots from jobbers. An artistic clothes hamper recently was designed by a Central Western manufacturer and these, made of 28 and 30 gage sheet steel, are being turned out at the rate of 1500 per day.

Use of containers increased during 1936 and required larger quantities of sheets and tin plate than heretofore. There was an expansion in the demand for steel barrels for food products and the use of tin cans for beer increased materially. Canned wine made its appearance, this being vacuum packed, whereas beer is pressure packed. However, beer barrels did not show an upward trend in the demand as did other types of containers. These

moved slowly, this being due to a large extent to the opposition of union labor to the use of steel beer kegs because they are made in open shops.

More steel drums are expected to be used because of a recent ruling of the Interstate Commerce Commission approving the use with certain exceptions of single trip containers for shipping dangerous liquids that flash below 20 deg. F. Products that are not to be allowed to be carried in single trip drums will be determined by the Bureau of Explosives of the American Railway Association.

Use of tinplate is growing and an increased demand has developed for black plate and terne plate for making small articles. Coffee cans were made last year in an experimental way of black plate and these with a gun metal finish look as good as those made of tin plate and are said to be cheaper.

The manufacture of bottles of light gage black plate was one of the most interesting developments in the container field. These bottles recently brought out by the Crown Cork & Seal Co., Inc., are shaped much like the type of beer can that has a cap. The body of the bottle is drawn and the bottom is double seamed into the body so that no soldering is required. The bottle is given a lacquer coating. These non-refillable steel bottles are designed particularly to take the place of glass bottles for beer or any other beverage that can be packaged in a container of this kind.

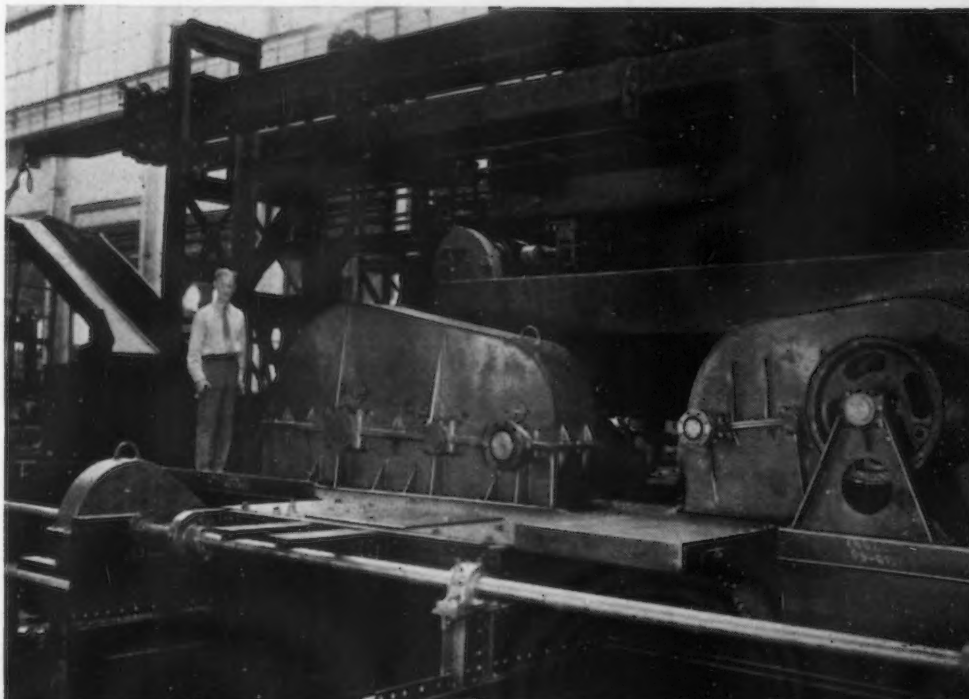


tank fabricated by Davis Welding Cincinnati.

conveniences for the housewife and resulting in greater use of sheet steel, were brought out during the year.

Recent additions to household equipment include a complete electric and all steel kitchen that has been brought out by the General Electric Co. This kitchen, prefabricated in 2-ft. units which may be built into a room eliminating the finishing of wall surfaces back of the combined units, consists of a range, combined sink and mechanical unit for disposal of waste food products, dish washer and refrig-

A COKE pusher fabricated by Wellman Engineering Co., Cleveland, for Carnegie-Illinois Steel Corp., with a considerable saving as compared with castings.





CARNEGIE-ILLINOIS Steel Corp.'s 96-in. continuous mill at South Chicago works.

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# CONTINUOUS STRIP MILL

*Additions to continuous strip-sheet rolling capacity do not yet threaten serious overcapacity as flat-rolled steel uses expand and some old type mills face obsolescence*

° ° °  
By T. C. CAMPBELL

Pittsburgh Editor, *The Iron Age*  
° ° °

IN the light of steel consumption trends of the past six months it would appear that the fears entertained a year or two ago that further installations of continuous strip-sheet mills would result in serious overcapacity are groundless and were largely the result of "depression thinking."

With the new mills that are very nearly completed at the beginning of 1937 plus those already scheduled to be built this year, the aggregate capacity of continuous mills for flat-rolled products that have been built since the American Rolling Mill Co. installed the first one in 1926 will be upward of 12,000,000 tons by the end of 1937, not counting one or two other large installations not yet officially announced. Three that have been definitely announced within the

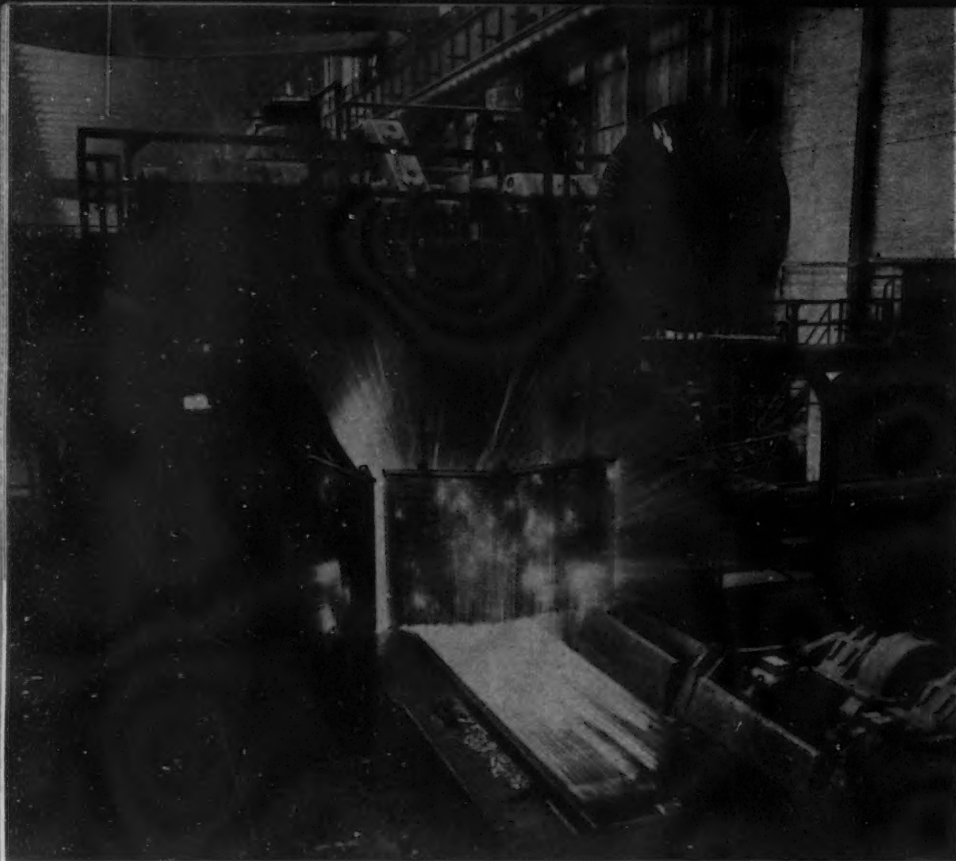
past few months are a 98-in. mill for Republic Steel Corp. at Cleveland, with annual capacity of 700,000 tons; a 56-in. mill for Bethlehem Steel Co. at Sparrows Point, Md., with annual capacity of 600,000 tons, and a 48-in. mill for the Tennessee Coal, Iron & Railroad Co. (United States Steel Corp.) at Birmingham, with annual capacity of 300,000 tons.

Fears concerning continuous hot mill installations were based on the belief that too much capacity would result with respect to potential demand. Figures were cited to show the large capacity of hand sheet and strip mills, which were added to the estimated capacities of the new continuous mills, resulting in an impressive total. The latter appeared to be twice the amount of sheets and strip ever consumed. It is appropriate to mention that during the last quarter of 1936 the majority of sheet mills were "sold out" and backlogs on some items were six to eight weeks. Consumers were not only pushing for delivery but were

frantically "shopping around" to get better shipping promises. Strip mills were not as greatly pushed, but were two to three weeks behind on some hot rolled sizes. Equally important was the absence of speculative buying. There was anticipatory purchasing, but only because consumers faced the danger of not getting material fast enough to keep in step with demand for their own products.

## Old Type Mills Kept Busy

Such conditions would have been unbelievable two years ago. To compensate for the fact that all the new continuous mills were not yet in operation, many old type sheet mills of large companies, long ago considered to be "out of production," were conditioned and set going at top speed. One company's old type mills at Buffalo were going full tilt during the last quarter of 1936, notwithstanding the fact that this company six months ago started in production a modern and up-to-date sheet-strip mill. Another large company



**I**NGOT receiving its first pass through the slabbing mill of Carnegie-Illinois Steel Corp.'s continuous mill at South Chicago. Twenty-five passes through the rolls reduce the ingot to a slab  $4\frac{1}{2}$  in. thick, 60 in. wide and 35 ft. long.

was forced to cancel a scrapping program for some of its old mills, owing to heavy demand for sheets. Meanwhile, most of the small non-integrated companies using equipment not of the continuous type were doing extremely well, considering the fact that only a few years ago predictions were freely made that many of them would be out of business.

Even considering the fact that one large continuous mill is now under construction and at least three are to be finished within a year, there is not enough evidence to justify fears of serious over-capacity.

#### New Mills Supplant the Old

Overlooked in the quest for statistics is the practical point that many of the new continuous mills supplanted old style equipment. These old type mills actually exist, are kept in condition, and are considered on the auditor's books, but mill superintendents long ago counted them as "dead," to be buried when written off and when it was sure they would not be needed. The inclusion of the rated output of these old mills in the total capacity figure, while theoretically

correct, does not give a true perspective of actual conditions.

Overlooked by some were the uses to which the products of the continuous mills would be put other than sheets. For instance, it is now known that a fair part of the tonnage from new installations has gone and will go into hot strip and then cold reduced for tin plating, skelp for pipe production, and lighter gage plates to replace antiquated plate mill equipment. An analysis of one large mill now practically completed, which has a capacity of 720,000 tons annually, and is designated as a continuous wide strip-sheet mill, shows that it can operate close to 50 per cent without making commercial sheets or strip. This mill will roll skelp, light plates, and strip for tinning, in addition to regular sheet mill products. The same condition applies to many of the other recent installations and those now under construction.

It was thought by some that the addition of so much continuous mill capacity would radically affect the sheet and strip price structure. This was predicated on the belief that large producers would have to fill up on tonnages in order to

pay the cost of maintaining the new type mill. These conclusions originated at a time when the trend of all steel prices was unpredictable, let alone sheet and strip quotations. The weakness in prices of the lighter rolled products, which resulted in \$3 and \$5 concessions from published prices during the first quarter in 1936, were caused as much by lack of general demand as by the sizable capacity of sheet and strip mills. What



**W**ORKMAN guiding strip into the coiler as

happened since that time is well known. Prices strengthened as demand increased; the right of large buyers to concessions was publicly recognized; details on the quantity differential set-up were revised to meet actual conditions and price increases were gained. The general acceptance of higher quotations for the first quarter of 1937 assures the success of the new prices because of demand and the realization that the new continuous mills were not the "never ending tonnage producers" once

thought. It cannot be denied that sheet and strip prices might decline periodically as demand will not always hold up as it has in the past several months. Producers will, as time goes on, manufacture more economically, which will be reflected in a change of the price structure. This will result from a natural economic leveling off rather than by frantic attempts to get tonnage regardless of costs. It is not amiss to observe that some



it leaves the last stand of a 96-in. continuous mill.

companies in the past have gotten their fingers badly burned and their balance sheets out of balance by accepting orders at prices which were below actual cost of production.

#### No Wholesale Exodus of the Small Mills

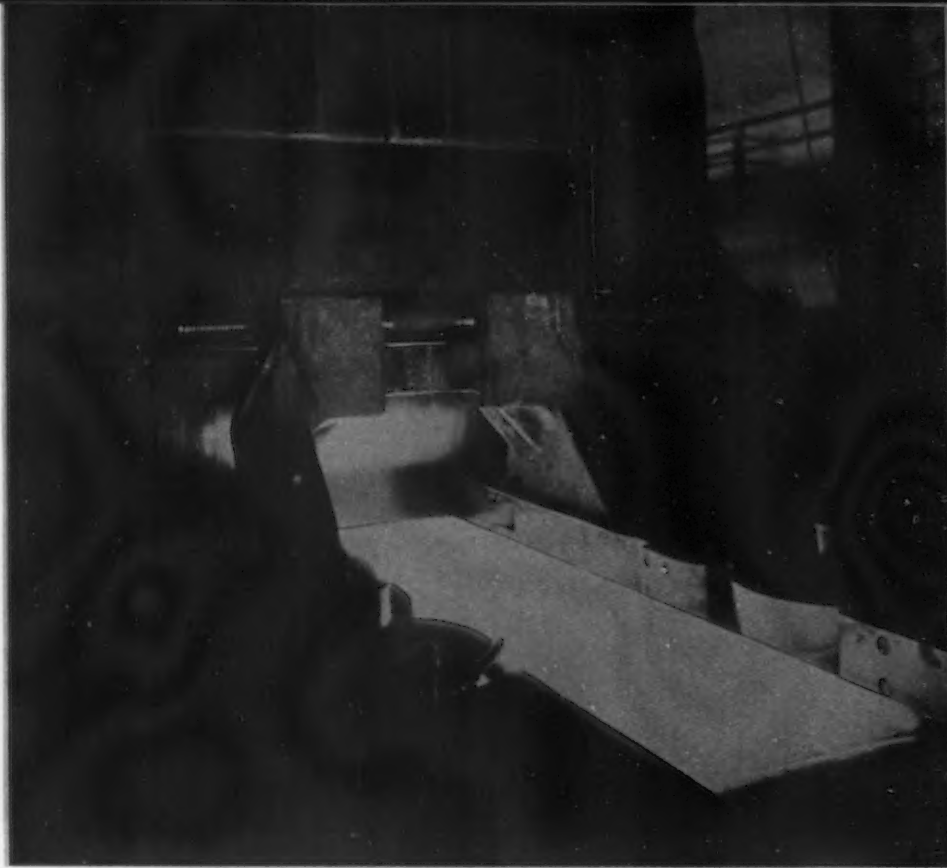
Most of the non-integrated mills which, because of financial condition and size, were unable to purchase expensive mill equipment and which were "to go out of business" when continuous mills "get

going" are still extremely active. Some of those that fell by the wayside probably would have done so—continuous mills or no continuous mills. Some of the smaller producers had their heyday during the depression owing to low semi-finished steel cost and a relatively good differential between that and finished prices. Large integrated mills at that time were having their financial structure strained, carrying large manufacturing costs all the way back to the ore without benefit of high production and good demand. There does not appear to be any sign of a wholesale exodus of the "little fellow" because of continuous mill installations. Some will go because their policies and set-up are not economically tuned to present conditions, but there has always been room for the small company and there always will be for those whose business is run on up-to-date methods and whose executives are far-sighted—but this applies to any business enterprise.

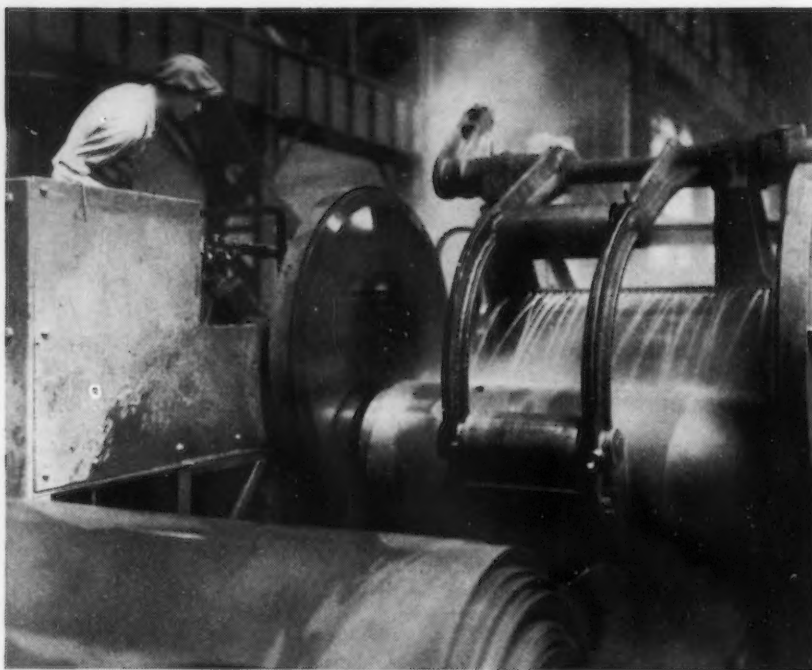
The small company whose management keeps production at the lowest cost consistent with good quality has an excellent chance to obtain orders during the time the large mills are learning more

about what their continuous equipment is capable of doing. The factor of delivery will also continue to throw orders to the smaller companies. This is the case at the present time and it will occur again.

The strong point of the small producers is the trend toward specialization on the part of some. Manufacture of special sizes or grades will enable the small mill to build up a good business that will in no way be affected by the larger mills. As the latter are interested in large tonnages, the non-integrated makers have and will continue to pick up small-lot orders. Another outlet for the smaller companies would lie in their geographical position. They have and can build up a local business by serving customers who do not desire to buy from distant points. There are two different spheres of activity for the continuous mills and the smaller company and yet each can without undue harm reach over into the other's field. It is confidently predicted, however, that some of the more enterprising companies whose size does not warrant the large outlay required for continuous mill equipment, will certainly continue



**R**EDUCING thickness of strip on continuous mill by the horizontal rolls and holding it to proper width by the vertical or edging rolls. Mill operates at a speed of 900 ft. per min., the first stand reducing slabs 50 per cent in gage.



**S**TEEL sheets 69-in. wide x 0.090 x 200 ft. being coiled after rolling on 96-in. continuous mill, each coil weighing 4200 lb. The coiler operates at the speed of the mill—900 ft. per min.

to adopt production and machinery improvements which will enable them to successfully compete in the sheet and strip market.

#### New Steel Uses Expand

All arguments given so far in a justification of the present and contemplated sheet and strip capacity have been without benefit of the question of new uses for steel. The steel industry has of necessity been geared for a greater production than can consistently take place except in peak demand periods. Aside from automobile demands, which really gave rise to the large continuous mills, growth of orders from other sources is taking place at a rapid rate. Much of this new volume can be traced to new uses. The office furniture industry is taking far more steel than formerly. It goes without saying that the air-conditioning industry holds tremendous promise for makers of sheet steel. Railroad cars, both freight and passenger, are certain to require more sheet steel than formerly and there is no reason to believe railroad buying is not going to increase steadily. Numerous other uses are covered elsewhere in this issue. Pent-up demand, unsatisfied after five years of depression, will play an important part in utilizing the sheet and strip capacity of the country for the next few years at least.

Of course there will be times when the continuous mills will be

idle and eating into reserves. Such is the case with all equipment. But for normal periods there does not appear to be so much capacity that disastrous consequences will result.

Summing up the present outlook it can be said: (a) Much of the present capacity is really replacing old type mills which, although carried on the books, are really "out of the picture"; (b) much of the present capacity of continuous mills will be absorbed in plate production, skelp production and tin plate production; (c) prices may in the future become affected by the capacity, but it appears it will be a healthy economic leveling off; (d) there is no cause for alarm over non-integrated mills which are economically managed and tuned to meet the times since they have a mission of their own to perform; (e) increased uses for sheets and strip will alleviate unused capacity as time goes on, although it is normally expected that continuous mills cannot run at 100 per cent consistently any more than steel ingot production can be maintained at 100 per cent of capacity.

#### Continuous Sheet and Wide Strip Mills Installed or Under Construction in the United States With Approximate Capacities

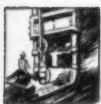
Name of Company and Location of Mill	Year Started	Size, In.	Annual Capacity Gross Tons
American Rolling Mill Co., Ashland, Ky.....	1926	48	432,000
American Rolling Mill Co., Butler, Pa.....	1926	48	315,000
Republic Steel Corp., Warren, Ohio.....	1927	42	302,000
Weirton Steel Co., Weirton, W. Va.....	1927	54	420,000
American Sheet & Tin Plate Co., Gary, Ind.....	1928	42	360,000
American Rolling Mill Co., Middletown, Ohio.....	1929	72	372,000
Wheeling Steel Corp., Steubenville, Ohio.....	1929	60	540,000
Great Lakes Steel Corp., Ecorse, Mich.....	1930	38	400,000
*Carnegie-Illinois Steel Corp., South Chicago, Ill.....	1931	96	720,000
Otis Steel Co., Cleveland.....	1932	72	375,000
Inland Steel Co., Indiana Harbor, Ind.....	1932	79	600,000
Allegheny Steel Co., Brackenridge, Pa.....	1932	38	275,000
†Youngstown Sheet & Tube Co., Indiana Harbor, Ind.....	1934	72	214,000
Youngstown Sheet & Tube Co., Campbell, Ohio.....	1935	79	600,000
Carnegie-Illinois Steel Co., Gary, Ind.....	1935	38	270,000
Ford Motor Co., Detroit.....	1935	56	500,000
Carnegie-Illinois Steel Corp., MacDonald, Ohio.....	1935	42	300,000
Bethlehem Steel Co., Lackawanna, N. Y.....	1936	79	600,000
American Sheet & Tin Plate Co., Gary, Ind.....	1936	80	600,000
Great Lakes Steel Corp., Ecorse, Mich.....	1936	80	600,000
Granite City Steel Co., Granite City, Ill.....	1936	90	375,000
*Carnegie-Illinois Steel Corp., Homestead, Pa.....	1936	100	729,000
Jones & Laughlin Steel Corp., Pittsburgh.....	1936	96	720,000
TO BE BUILT IN 1937			
Bethlehem Steel Corp., Sparrows Point, Md.....		56	600,000
Republic Steel Corp., Cleveland.....		98	700,000
Tennessee Coal Iron & Railroad Co., Birmingham..		48	300,000
			12,219,000

\* These mills are continuous and semi-continuous plate mills, but are capable of rolling heavier gage sheets.

† Revised.

# ***TIN PLATE***

***Cold Reduced Product Gradually Dis-  
placing Hot Mill Plate as Capacity  
Climbs to 30 Per Cent of Country's  
Total Facilities With 42 Per Cent in  
Sight by End of 1937***



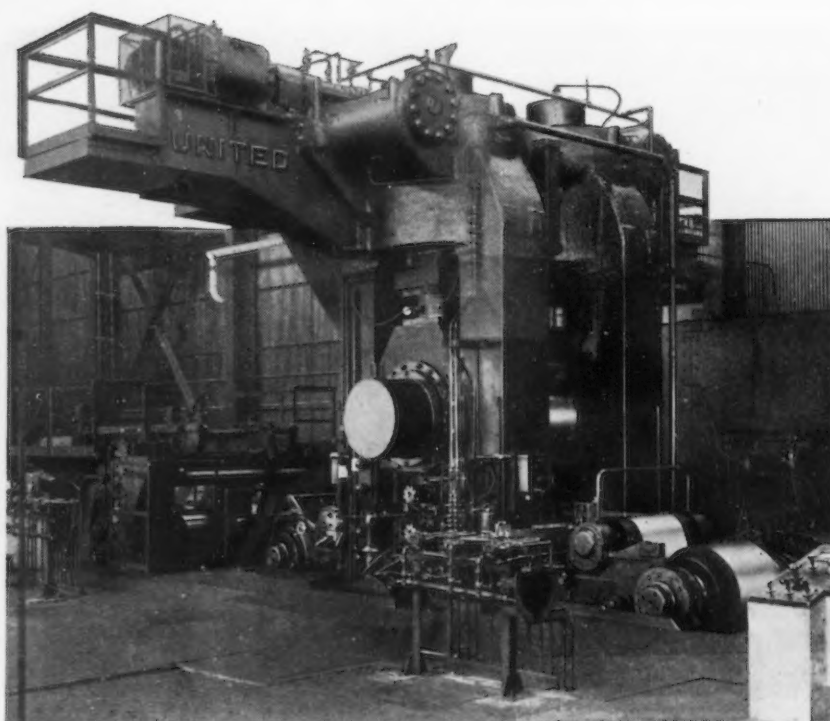
THE trend toward cold reduced tin plate production, which began about four years ago, has been gaining momentum until at the present time approximately 30 per cent of the total capacity used in making tin mill products is comprised of cold reducing facilities. Some of the pioneers in this method of manufacture have increased their cold reducing capacity to as high as 78 per cent of the total. Of course, in obtaining this high percentage, these companies have scrapped a considerable number of their old type hot tin mills. One steel company makes only the cold reduced grade, since it did not begin production of tin plate until after the trend toward cold reduction began. While prac-

tically all of the larger steel companies now have cold reducing capacity, at least seven plants are without it and there is no new construction taking place at their plants at the present time.

A large portion of the present cold reduced capacity shown in the table on the following page was completed some time after the middle of 1936, while in one or two cases this type of production has just gone into operation. With estimated production of tin mill products for 1936 at about 2,500,000 tons, it can be seen that practically 80 to 85 per cent of all existing hot tin mills were in operation at some time or other in 1936. This factor alone is a major reason why the trend toward cold reduced tin plate has not moved at a faster pace.

Demand for cold reduced tin plate has increased considerably within the past year. While there are several reasons why this type of manufacture is considered to be superior to the pack roll product, the simple reason behind the heavy demand is that the customers used the cold reduced tin plate, liked it, and demanded more of it. Considerable experimentation and refinement of manufacture necessarily had to take place before steel companies were in a position to produce a completely satisfactory article. These changes, however, were rapidly made and it is probably true to say that cold reduced tin plate as it is now made will suit the needs of any customer.

In some cases it is superior to hot tin mill plate. The outstanding characteristic claimed by its pro-



**A** FOUR-HIGH reversing cold mill for tin plate, built by United Engineering & Foundry Co.

ducers is the better gage tolerances obtained by the cold reduced process. Some customers have said their die life has increased two-fold since they began using cold reduced plate. It is also possible to get better size tolerances on the cold reduced product than on the hot rolled product. More important to the customer is the fact that the cold rolled product is more ductile and performs more satisfactorily under deep drawing conditions. Without loss of ductility, it is possible, by ladle additions in the steel, to produce a tin plate a little bit stiffer than the hot mill product, a characteristic desired by many makers of cans and other containers.

#### Resistance to Corrosion Important

Still another feature which has increased the demand for cold reduced tin plate is the fact that it seems to have a greater resistance to corrosion. This trait is probably traceable to the refined grain structure which results because of the cold reducing operation. Makers of cans which are used in packing acid fruits, such as cherries, are loud in their praise of this particular characteristic of cold reduced tin plate.

It has also been found that there is less porosity in cold reduced tin plate, hence a smoother finish. In

other words, "it looks good," and this one factor alone has caused several buyers of tin plate to in-

sist on the cold reduced grade, even though hot tin mill plate would have been fully satisfactory for the use intended.

#### Hot Rolled Tin Plate Satisfactory in Many Cases

In considering the whole question of tin plate, it must not be overlooked that the hot mill product is perfectly satisfactory in a great many cases. Where deep drawing is not the prime factor and surface is not especially important, hot rolled tin plate can adequately fill the bill. There are some can manufacturers who use cold reduced plate for the top of the can which is exposed, and hot rolled tin plate for that portion of the can which is covered by either labels or enamel. In addition, there are a host of other uses for which hot rolled tin plate is satisfactory. It is not to be supposed, therefore, that a complete replacement of hot rolled tin plate by the cold reduced product will take place, if at all, for quite some time.

#### Cold Reducing Capacity Construction Going On

Practically all of the recently announced hot strip mill installations

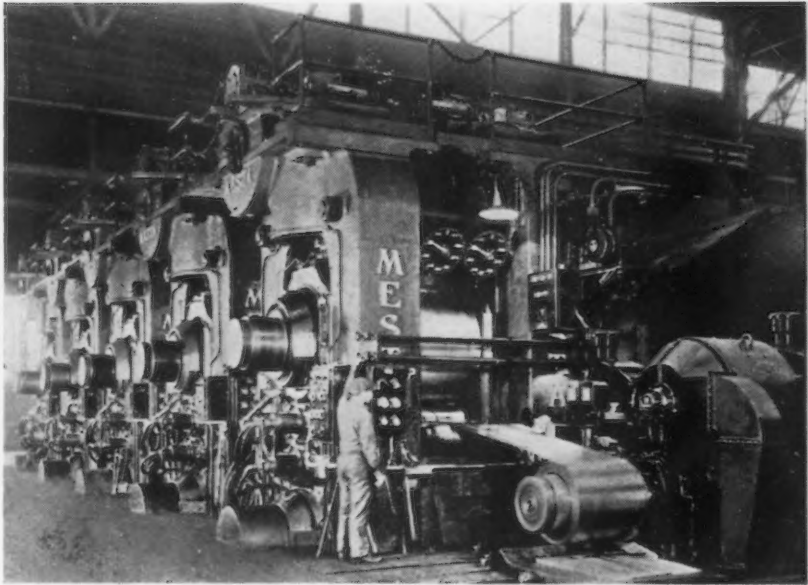
#### ANALYSIS OF PRESENT HOT AND COLD AND COLD REDUCED

Company	Hot Mill	Present Capacity in Annual Net Tons				Total Capacity
		Per Cent of Total	Cold Reduced	Per Cent of Total		
Carnegie-Illinois Steel Corp.	1,050,000	84.0	200,000	16.0		1,250,000
Columbia Steel Co.	33,600	100.0	None	...		33,600
Wheeling Steel Corp.	108,000	47.0	120,000	53.0		228,000
National Steel Corp.	82,320	22.0	292,660	78.0		374,980
Inland Steel Co.	None	...	125,000	100.0		125,000
Bethlehem Steel Co.	214,000	68.0	100,000	32.0		314,000
Youngstown Sheet & Tube Co.	112,000	58.0	80,000	42.0		192,000
Granite City Steel Co.	84,000	72.0	33,000	28.0		117,000
Jones & Laughlin Steel Corp.	159,000	75.0	54,000	25.0		213,000
Republic Steel Corp.	173,600	85.0	30,000	15.0		203,600
Follansbee Brothers Co.	65,000	80.0	16,000	20.0		81,000
Washington Tin Plate Co.	31,500	100.0	None	...		31,500
Empire Sheet & Tin Plate Co.	36,000	100.0	None	...		36,000
Continental Can Co.	123,200	100.0	None	...		123,200
Tennessee Coal, Iron & Railroad Co.	None	...	None	...		None
McKeesport Tin Plate Co.	201,600	100.0	None	...		201,600
Total	2,473,820	70.0	1,050,660	30.0		3,524,480

Note: To convert to base boxes

are to be supplemented with cold reducing facilities, part of which will be used for reducing strip for tinning. There is approximately 500,000 tons annually of such capacity now under construction, while the remainder of the new capacity is for those companies where it has been found necessary to purchase additional equipment in order to keep up with the demand for the cold reduced product. It is interesting to note that the Tennessee Coal, Iron & Railroad Co. will, some time in 1937, have a cold reducing capacity for tin plate of approximately 200,000 tons annually.

That the trend toward more cold reducing capacity will continue at a rapid pace in 1937 is shown by the figures which indicate a rise from 30 per cent of total tin plate capacity at present to 42 per cent after cold reducing capacity under construction is completed. However, this figure is probably too low, inasmuch as a large percentage of hot tin mills are actually being supplanted by new cold reducing capacity, and there is every evidence that 1937 will see many of the pack mills abandoned and dismantled. For statistical pur-



o o o A FOUR-HIGH, five stand, cold reducing mill for tin plate built by Mesta Machine Co.

poses, however, it is necessary to retain the known hot tin mill capacity and incorporate it into the total which may exist after present construction is completed. Proof that a considerable amount of hot tin mill capacity will be

abandoned in 1937 is found in the action of some companies, which did exactly that in 1936. As pointed out before, the only factor which prohibits a more rapid abandonment of pack roll equipment is the healthy current demand for tin mill products, which is increasing considerably owing to new uses being found for tin plate. As an indication of the rapid change-over, it is only necessary to realize that almost as much new cold reducing tin plate capacity is now under construction as that which now exists.

The figures appearing in the table are reliable estimates, and in practically all cases have been verified by the steel companies involved.

In summarizing the cold reduced tin plate situation, it may be said: (a) Present capacity accounts for 30 per cent of total tin plate capacity; (b) after mills under construction are completed, cold reducing capacity will reach approximately 42 per cent of the total and in reality will probably be much higher, owing to possible scrapping of pack roll equipment; (c) customers are demanding cold reduced tin plate because of its superiority in certain manufacturing operations; (d) uses of tin plate are increasing materially; (e) new capacity will result in more efficient operations; (f) trend will continue until a large part of present hot tin mill capacity is supplanted.

REDUCED TIN PLATE CAPACITY  
CAPACITY UNDER CONSTRUCTION

Cold Reduced Capacity Under Construction	Capacity in Annual Net Tons After Construction is Completed Hot Mill	Per Cent of Total	Total Cold Reduced	Per Cent of Total	Total Capacity
112,000	1,050,000	77.0	312,000	23.0	1,362,000
None	33,600	...	None	...	33,600
144,000	108,000	29.0	264,000	71.0	372,000
None	82,320	22.0	292,660	78.0	374,980
None	None	...	125,000	100.0	125,000
125,000	214,000	49.0	225,000	51.0	439,000
None	112,000	58.0	80,000	42.0	192,000
....	84,000	72.0	33,000	28.0	117,000
67,000	159,000	57.0	121,000	43.0	280,000
100,000	173,600	57.0	130,000	43.0	303,600
None	65,000	80.0	16,000	20.0	81,000
None	31,500	100.0	None	...	31,500
None	36,000	100.0	None	...	36,000
None	123,200	100.0	None	...	123,200
200,000	None	...	200,000	100.0	200,000
None	201,600	100.0	None	...	201,600
748,000	2,473,820	58.0	1,798,660	42.0	4,272,480

multiply Capacity figures by 20



MORE than seven billions of dollars is estimated to have been spent for construction in this country during 1936, this sum representing total expenditures for all types of construction, public and private, inclusive of alterations and repairs. While the industry benefitted from this outlay, it continued over the year to give evidence of subnormal conditions.

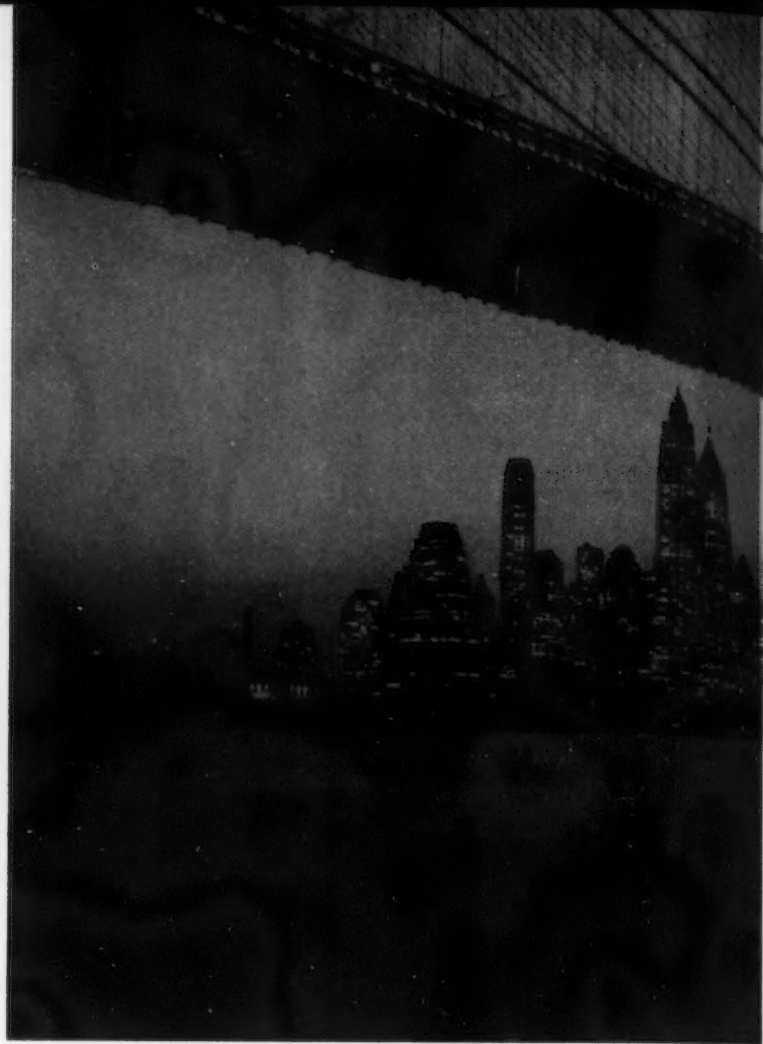
During the period from 1925-'29 inclusive, construction volume averaged approximately 12 billion dollars annually, but declined in the period from 1932-'35 to an annual value of less than 4½ billion dollars. In 1928, when building activity was at a peak, nearly 12¼ billions was expended for construction. By 1933, however, volume had contracted to a record low of about 3½ billions, or only slightly more than one-quarter of the 1928 peak. The next two years brought a gradual but consistent increase, which tended to accelerate last year.

The construction industry is the largest single market in the durable goods field, and the prosperity of industry generally is in large measure dependent upon it. Its ups and downs affect still other industries, for in 1929 one-fifth of all freight handled by Class 1 steam railroads comprised construction materials, and 15 per cent of their revenue derived from this source.

#### Low Building Volume Affects Labor Market Acutely

Ordinarily the industry affords employment to millions of workers. In 1929 upward of three million

wage earners were directly attached to it, and an even greater number depended upon construction for their normal employment in the fabrication, manufacture and distribution of building materials. By 1934 the number of workers had shrunk to slightly more than one-third of the volume in 1929. The drop was especially marked in private construction, which in 1934 was about one-sixth of the volume in 1929. It is evident, therefore, that periods of depressed building activity are accompanied by extensive increases in unemployment. The large outlay of funds for public works con-



# CONSTR



# CONSTRUCTION

By N. E. MACMILLAN  
*Associate Editor, The Iron Age*

struction during the depression was stimulated by Federal initiative in attempting to combat this problem.

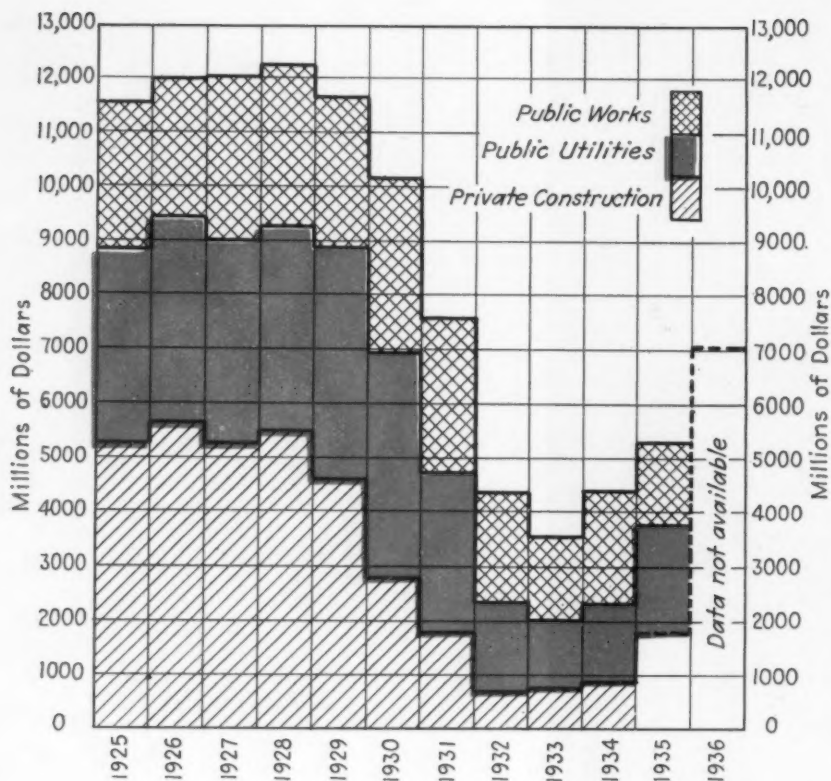
With the advent of the depression, the shrinkage in construction volume affected private enterprise acutely. Chart I, which divides total construction into three major classifications, shows a relatively greater recession in private work than occurred with respect to either public works or public utilities. By private construction is meant residential, commercial, factory, farm and miscellaneous building. Public utilities denote expenditures for railroads, electric

power, pipe lines, waterworks and related undertakings. Included in the public works classification are the expenditures for construction of municipal, state and Federal agencies.

The collapse of private building initiative was so serious that its volume, which averaged 44 per cent of total construction during

*We may look forward to a continuance of the upward trend in construction through 1937. But public works and utilities will continue to be the leading factors, with private enterprise running third.*

the period from 1925-29, declined to only about 15½ per cent in 1932. On the other hand, public utilities gained in relative importance from about 32 per cent of the total during 1925-'29 to 38 per cent by 1932. Public works rose most of all, having accounted for approximately 24 per cent of all work in the 1925-'29 period as



against 46 per cent in 1932. More recently, as in 1934, for example, the relative importance of private construction increased to about 19½ per cent of total volume, compared with a lesser gain to 48 per cent for public works and a drop to not quite 32½ per cent for public utilities.

#### Public Construction Receding

By 1935 public construction commenced to recede. The utilities showed very little change, and the gain in total enterprise was therefore due to large increases in private work. At the time Chart I was being prepared, however, no official estimate of total private building activity in 1936 was available. A figure was used determined partially with reference to percentage increases in other indices of construction activity.

The trend of activity during 1936 can best be studied by utilizing the reports of the F. W. Dodge Corp. These reports, based on the dollar value of contracts awarded monthly in 37 Eastern states, cover all types of construction. Broken down as to public and private undertakings, they show in Chart II primarily a large expansion in public work for 1934 but a material increase in private activity

thereafter. During six out of 11 months of 1936, the Dodge reports of private construction volume exceeded the total for public projects of every description. Included were the consecutive months of September, October and November.

A significant aspect of the industry's improvement during 1935 was the sharp upturn of residential building in all parts of the United States. This process was repeated during 1936 and in 11 months of that year more than 736 millions of dollars was expended for residential buildings in the territory embraced by the F. W. Dodge Corp. reports. This represented a gain over 1935 of 70 per cent. While expenditures for non-residential construction totaled upward of 880 millions, the improvement relative to 1935 was less, at about 60 per cent.

#### Residential Building Increasing

The trend in residential building activity since 1925 is depicted relative to total construction in Chart III. Last year, according to Dodge contract figures, approximately 30 per cent of the value of all construction awards was for residential buildings. Until 1935, however, this class of work remained unstimulated, having declined from

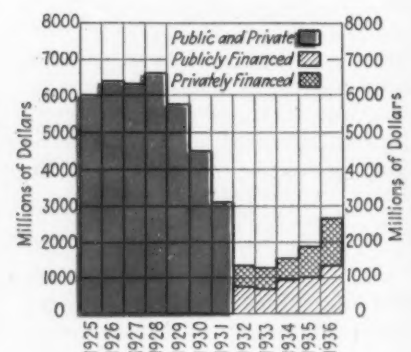
nearly 41 per cent of total volume during the period from 1925-29 to not quite 19 per cent in the period from 1932-34. Recently residential building has tended to gain more rapidly than total volume, the 11-months indicated increase for 1936 over the preceding year having been 70 per cent as against 56½ per cent for all construction work.

Upward changes in the dollar volume of other types of construction, as for example large heavy engineering projects reported by the *Engineering News Record*, have also occurred. Chart IV presents a graph of this activity accompanied by a curve based on F. W. Dodge figures. Since 1933 both indices have steadily mounted. The discrepancy between the two curves prior to 1931 when large-scale residential activity materially influenced the Dodge reports is due in part, at least, to exclusion of this type of construction from the *Engineering News Record's* data.

The estimated total volume of construction of all types in the United States, as reflected by Chart I, has not been determined with respect to 1936. Its expected volume, as based on percentage increases in other representative indices, probably was somewhere between six and one-half and eight billions of dollars. There would thus have occurred last year an appreciable further advance in this industry toward complete revival, resulting in a total volume of business equivalent to at least one-half, or possibly three-quarters of average annual volume during the 1925-'29 period. A reasonable estimate falls around a seven billion dollar level.

#### Upward Trend Should Continue

Numerous factors point to continuance of this trend during the

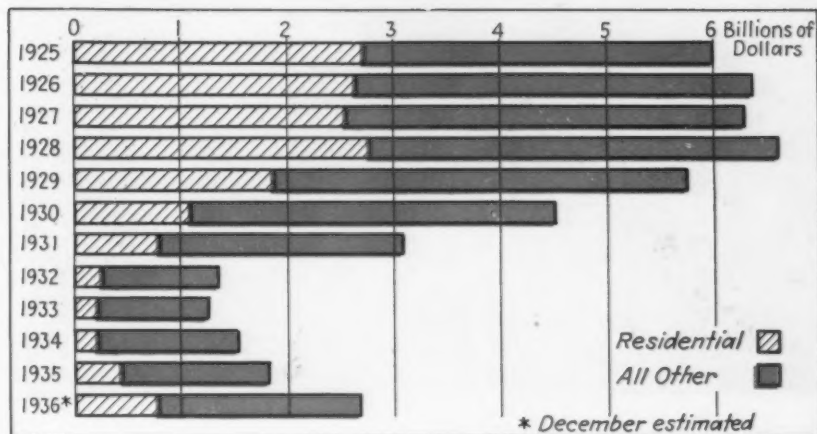
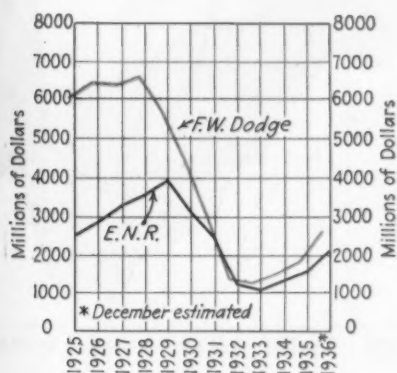


current year. Primarily long-term fluctuations in the building cycle have been observed to repeat themselves with approximate regularity over the past 100 years or more. Periods of appreciable activity, stretching from 12 to 18 years in length, alternate with eras of corresponding dullness. Consequently it is logical to assume that the present phase of expanding activity will endure for several years more.

This assumption is fortified by a number of favorable considerations, economic in character. For one thing, the large volume of funds of lending agencies available for investment and lower interest rates than have prevailed for several years tend to confirm such an expectation. Rising rents and diminishing vacancy of dwellings offer additional evidence. Moreover, total construction work will continue to be augmented in 1937 by public works projects of the Federal Government.

#### Potentially Expanding Market for New Homes

Residential building expansion should exert an appreciable influence. In recent decades the population of the United States has increased by about five million families every 10 years, thus creating a potential demand for about 500,000 additional homes each year. This market has been recently curtailed by such factors as immigration restriction, entailing a resultant decrease in annual growth of population, and by the decline in the national income. The need for new residences, however, is periodically contributed to by such causes as obsolescence and the large number of dwellings destroyed each year by fire. Annual fire loss in the United States from



1929-'32 was approximately a half billion dollars, covering all types of construction.

#### Wider Use of Steel

Being the largest of industries, the construction field presents tremendous possibilities over the near future for growing consumption of durable goods. In proportion as these possibilities are realized, the market for brick, cement, lumber and steel, as well as numerous other products, should expand. While brick and lumber normally constitute the prime materials employed in residential home construction, a recent departure from established procedure, which may presage a new era in this field, is the pre-fabricated house. Present trends in this new technique indicate a reliance upon steel as an essential building medium.

Another aspect, the transference of much of the field operations to the factory, points to a widening use of mass production methods. As in the automobile industry, such a development would tend to lower unit costs and so open up a much broader market. The attendant growth in steel consumption would then be enormous.

#### Some Examples of Present Day Activity

Regardless of developments in this branch of industry, the construction field offers practical evidence of its potentialities as a consumer of steel and other durable goods in the large structural achievements of present day experience. Stupendous bridges, recently completed or in process of

building, immense irrigation and water-supply projects, extensive subway and vehicular tunnel construction in metropolitan districts, and expanding activity on the part of commercial and industrial establishments are representative of the trend of events.

The San Francisco-Oakland Bay Bridge on the West Coast, for example, erected at a cost in excess of 77½ million dollars, alone consumed some 200,000 tons of steel. New York City's recently completed Tri-Borough Bridge, which cost upwards of 44 million dollars, and San Francisco's Golden Gate Bridge, a 37 million dollar project, present additional evidence. If the proposed Liberty Bridge, to span the entrance to New York City's harbor, is ever built, it will be still larger than any single-span structure now in existence.

Quoting from a Department of Commerce survey, "construction underlies the whole economic organization of the country. Coming within the range and variety of its activities are the erection of residential, commercial, industrial, educational and religious buildings; the construction of roads, tunnels and bridges; the laying of tracks and of conduits for water, gas, oil, electricity and communication; including additions, alterations, and repairs. Closely allied are the industries which provide raw materials, equipment and structural units, and their transportation and distribution. Upon the availability and character of these facilities depend the industrial activities of the Nation, the living standards and health of our people, and the livelihood of millions of workers."



An open hearth receives a charge of steel scrap.

Van Fisher Photo

# SC



FROM an all-time low of \$6.46 a ton (**THE IRON AGE** composite price) in July, 1932, heavy melting steel scrap had recovered in 1936 to a level of \$17.75 by Dec. 22, the highest since September, 1925, when it was the same. A mounting domestic demand, coupled with continued large exports, which, at nearly 2,000,000 tons, were only about 4 per cent below those of 1935, rehabilitated the scrap trade, which in the lean

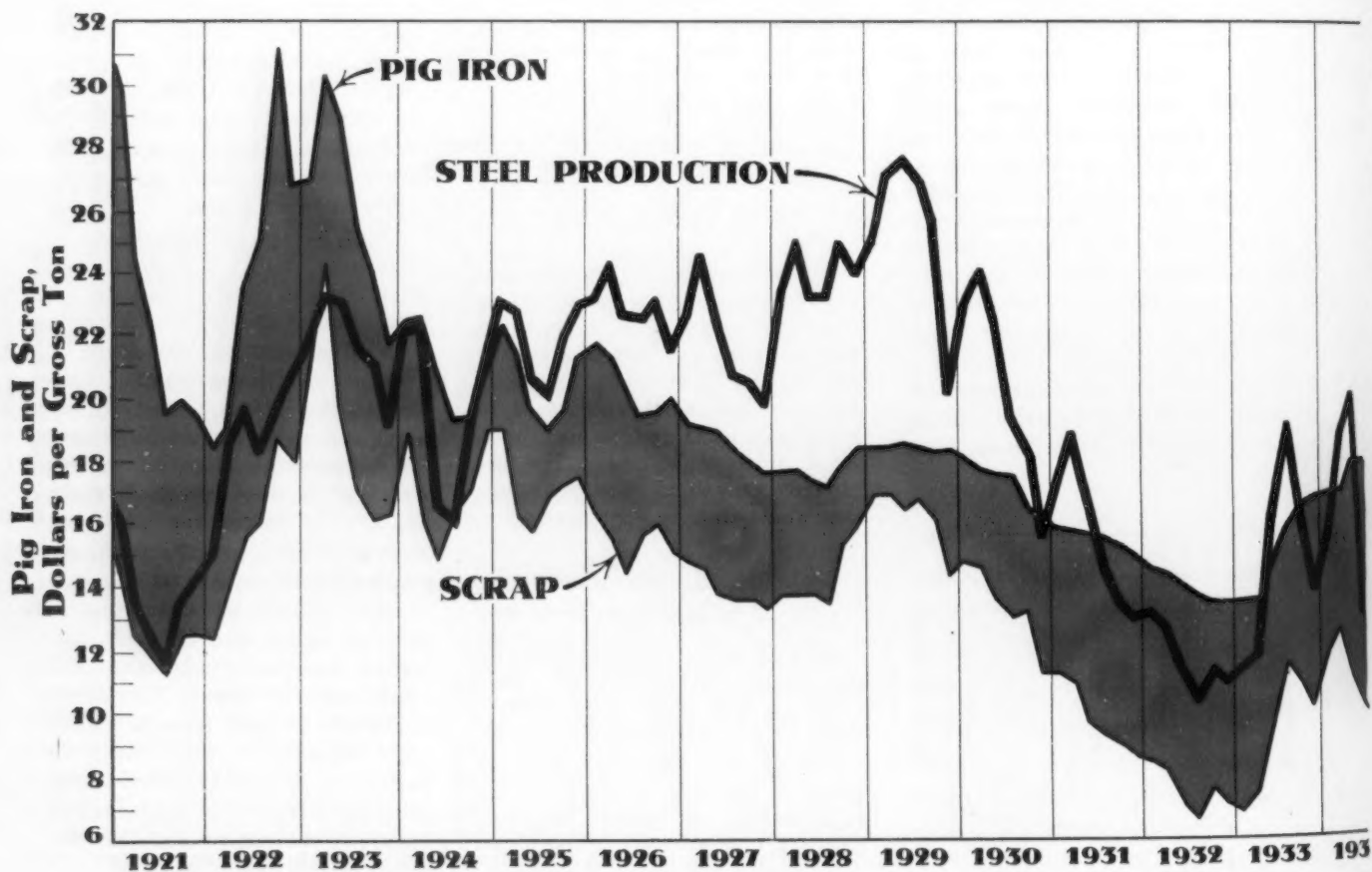
years of low prices and small consumption had barely escaped disintegration.

During the depression a considerable portion of the scrap trade was saved from extinction by heavy export demand, principally from Japan, which has continued in the past year in only slightly modified degree, thereby contributing to some extent to higher prices and potential scarcity in the United States.

Although it has not been estab-

lished that any actual shortage of scrap has existed, rising prices at one period (in September) gave that impression, with the result that mills increased their offering prices and thereby tapped more remote sources as well as supplies that had been hoarded for speculative profits.

Scrap consumption in 1936 probably totaled about 35,600,000 tons, of which about 17,500,000 tons was purchased scrap and the remainder home scrap. These estimates



# RAP

*Scarcity abroad causes drain upon American supplies as domestic mills require more, bringing price uplift*

are based on the survey by the United States Bureau of Mines of 1935 scrap consumption, which showed use of 13,068,578 tons of purchased scrap and 13,346,752 tons of home scrap, with adjustments made for the larger volume of steel production in 1936 than in 1935.

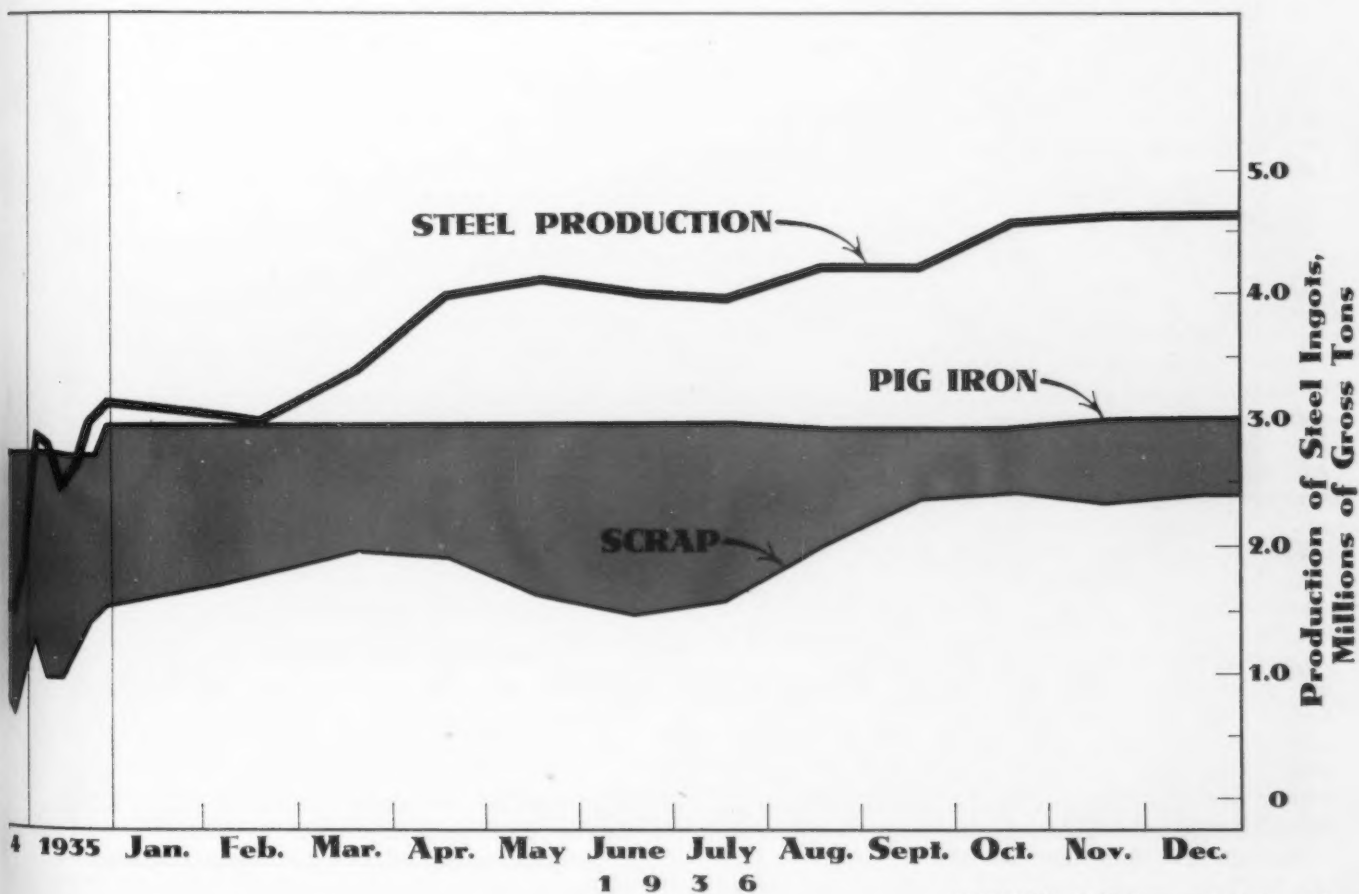
## Exports High in 1936

Export shipments of scrap for the year probably will total about

1,995,000 tons, this figure being arrived at by estimating deliveries in November and December, official figures for which are not yet available. The estimated 1936 exports of scrap were valued at about \$24,000,000, or 10 per cent higher than the 2,103,959 tons shipped abroad in 1935. At the end of 1936 export activity was confined almost entirely to deliveries on old commitments, as foreigners found prices here in the past few months too high to be

attractive. It is not doubted, however, that a drop of \$1 or \$2 a ton in American quotations would bring a fresh buying movement for shipment abroad.

Japan has been scouring the Far East in an effort to obtain scrap that she has been unable to get here at satisfactory prices. Japan went into world markets in 1936 for about 1,500,000 tons, the bulk of which was obtained in the United States, possibly as much as 1,128,000 tons (November and



December estimated) against 1,117,973 tons in 1935.

However, Japan was not alone in her search for scrap. The United Kingdom, the second largest buyer here, took an estimated 373,000 tons compared with 277,366 tons in 1935. With record-breaking steel production in Great Britain, market scrap has been virtually non-existent there and common steel-making practice is 70 per cent pig iron and 30 per cent scrap. Germany, though not a buyer here because of her monetary restrictions, has gone into the highways and byways of her own country with motion picture appeals to the masses to save old iron and steel materials and forward them to scrap collecting agencies. Italian imports from the United States in 1936 were only 236,000 tons, a decline of 146,775 tons from 1935. Canada also took less—about 58,000 tons against 96,000 tons in 1935, while Mexico was also a smaller buyer—32,000 tons against 41,436 tons in 1935.

#### Price Trend Upward

In the domestic market the year did not open with promises of what was to develop. Steel operations in early January were around 51 per cent of capacity, and the scrap composite price was \$13.33. But the outlook was fairly hopeful and scrap prices responded, the scrap composite price reaching a first-half peak of \$14.75 by Feb. 25, which continued until March 31. As shown by the graph on preceding page, ingot output followed the scrap advance to a rate of 62½ per cent in the week of March 31. In April and May, however, the scrap markets did not display the forecasting character with which they are commonly credited, and price averages dropped back almost \$2 a ton to a composite low for the year of \$12.67 in the early part of June. At that time scrap trade opinion became imbued with uncertainty as to the outlook for steel production over the remainder of the year, but it may be said in explanation that the steel industry itself did not foresee the rising trend that was at least partly set in motion by announcement of higher steel prices for the third quarter, resulting in what had been up to that time the largest buying wave since pre-depression days.

During this low-price period

steel companies contracted heavily for steel scrap, bringing a reversal in the price trend by late June. From that time there were steadily rising prices to a peak of \$16.75 in late September, accompanied by improving steel production, except for a slight leveling off in July and August as compared with June, which was due more to excessive heat than to lack of steel orders. Some scrap brokers did not find the mid-year business volume as profitable as might be expected, owing to the fact that continued strength in the market frequently forced them to cover short positions at a loss.

After the culmination of the price bulge in September, scrap prices turned weaker, not through lack of consumption, as steel production was going along at a rate above 75 per cent, but chiefly because mills had withdrawn from the market with fairly ample stocks and had resorted so far as possible to increased use of pig iron. A large company, in fact, used what the scrap trade dubbed "synthetic" scrap—bessemer ingots that were made over week-ends and used in the open-hearth charge.

A November steel output of 79 per cent, as shown by the figures gathered by the American Iron and Steel Institute, together with an exceptional buying movement in semi-finished and finished steel in late November and early December, gave fresh impetus to scrap prices, and the trend was upward in December, reaching \$17.75 by Dec. 22.

If steel production continues during the first few months of 1937 at the high rate that is now indicated, a further rise in scrap prices seems probable. This may be brought about not only by the needs of the steel plants, but by an impending shortage of pig iron. Moreover, winter ice and snow make it more difficult to gather scrap from remote sources and bring it to market, and a further factor is that higher cost of making pig iron, due to wage advances, and higher prices on merchant pig iron will force steel plants and foundries to use scrap in as large quantities as is economically feasible.

The spread between pig iron and scrap prices is an important factor in scrap consumption both by mills and foundries. During the past year the differential between these two commodities has narrowed. Taking THE IRON AGE composite prices as the basis for comparison, steel scrap was only 98c. a ton below pig iron on Dec. 22, the nearest the two had approached since Jan. 29, 1929. But at this same time basic pig iron at Valley furnace was quoted at \$20 and steel scrap, Pittsburgh, at \$19 to \$19.50.

To what extent there may be an actual shortage of scrap, as differentiated from an artificial shortage created by market opinions and market operations, will undoubtedly be determined during the next few months of unusual industrial activity.

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**M**OLTEN pig iron being poured into the open-hearth furnace, this operation taking place several hours after the steel scrap has been charged and partially melted. The ladle contains approximately 100 tons of hot metal. The photograph was taken at the South Chicago works of Carnegie-Illinois Steel Corp.

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**4**  
UNITED  
KINGDOM  
11,700,000 tons

**6**  
BELGIUM  
LUXEMBURG  
4,840,000 tons

**2**  
GERMANY  
19,300,000 tons

**3**  
U. S. S. R.  
16,100,000 tons

**5**  
FRANCE  
9,400,000 tons

# WORLD



**ACCELERATED** by armament requirements and active post-depression demands, the steel markets of the world staged a spectacular pick-up during 1936 to establish an all-time peak production level, with total output of ingots and castings estimated at 119,550,000 gross tons. This figure slightly overtops the previous high point of 1929, in which year output aggregated 118,511,000 tons. World pig iron production lagged somewhat, amounting to 89,434,000 tons, compared with the 97,883,000 tons made in the peak year of 1929.

During 1936, Germany, the U. S. S. R. and the United Kingdom all established new high points for steel production, whereas the United States, with output of ingots and castings estimated at 48,330,000 tons, lagged behind the 1928 level of 51,544,000 tons and was considerably under the 1929 high level of 56,433,000 tons. As compared with total world production, however, the United States and the U. S. S. R. were the only two countries accounting for greater proportions of steel in 1936 than in 1935. For the United States, output in 1935 was 35.25 per cent of the world total and in 1936 the figure rose to 40.76 per cent. The U. S. S. R. produced 12.80 per cent of the world output in 1935 and 13.58 per cent in 1936. Germany, France and the United Kingdom accounted for proportionately less of the world's steel in 1936 than in 1935.

The situation in pig iron and ferroalloys bore some similarity to that in steel. The United States, with estimated 1936 output at 31,310,000 tons, including ferroalloys, was by far the world's largest

producer, accounting for 35.16 per cent of the world total in 1936 against 29.38 per cent of the total in 1935. Although every major country showed advances in pig iron production in varying degree, all countries excepting the United States turned out proportionately less of the world's pig iron total in 1936 than in 1935. Germany, second largest world producer, produced 15,300,000 tons of pig iron and ferroalloys in 1936, accounting for 17.18 per cent of the world's total. The U. S. S. R. was a close third, with 14,090,000 tons, or 15.82 per cent of the world's total, and the United Kingdom, fourth producer, was far down the list with 7,710,000 tons, or only 8.66 per cent of the total world output.

It is possible that the U. S. S. R. may reach second place in pig iron during 1937. She is now only about 1,000,000 tons under Germany, and her yearly advance in pig iron has in the past several years been in the neighborhood of 2,000,000 tons. Currently, pig iron schedules in the U. S. S. R. are running slightly in advance of the demands of the steel-making plants, and enough surplus has been available in 1936 for sizable export shipments, with Japan as the largest single taker.

By T. W. LIPPERT

*The Iron Age, New York*

o o o

The rapid industrialization of the U. S. S. R. during the past decade has forced steel production in that country up at a spectacular rate. On the basis of 1935 figures it had generally been expected that 1936 production in the U. S. S. R. might possibly overtop that of Germany. However, concentrated exploitation of the Saar area, coupled with a widespread remilitarization program, served to force German production of steel ingots and castings up to an estimated 19,300,000 tons, an all-time peak level for that country and sufficiently high to give her plenty of leeway as the world's second largest producer. German export markets remained at a high level during the year, home business was accelerated by sizable orders from the State railroads and a sharp increase in shipbuilding and armament manufacture. Although satisfied with operations, Germany's steel producers were none too pleased with profits during the year, for costs expanded materially through the continuation of "charges" on domestic transactions for purposes of subsidizing export sales, and, also, because of the government edict requiring the use of more domestic ore, which is of low quality (25 to 30 per cent Fe)



**7**  
JAPAN  
4,230,000 tons

**1**  
UNITED STATES  
48,330,000 tons

# OUTPUT

*Establishes New High Level at 119 550,000  
Tons — United States Accounts for 41 Per  
Cent, Germany Is Second with 16 Per  
Cent, and U.S.S.R. Third with 14 Per Cent*

compared with foreign ores previously used (55 to 75 per cent Fe).

The U. S. S. R. is well established as third world producer of steel, with an estimated output of 16,100,000 tons of ingots and castings in 1936. If the Second Five-Year Plan of Development and Economy goes through on schedule, it is possible that during 1937 the U. S. S. R. may outstrip Germany; for the former has considerable new capacity scheduled to go into production during the year whereas Germany has little new melting equipment in prospect for 1937.

Like the U. S. S. R. and Germany, the United Kingdom established an all-time peak level of steel production last year, with the 12-months' total for ingots and castings estimated at 11,700,000 tons. Britain's export and domestic demands expanded sharply during the year, the former as a reflection of some clever diplomatic maneuvers and the latter due to the release of depression-delayed demands together with a feverish armament program. Currently,

the demands of the home market have so loaded up mills that export has been relegated to a secondary position. Current backlogs are heavy and peak production over the next several months is assured.

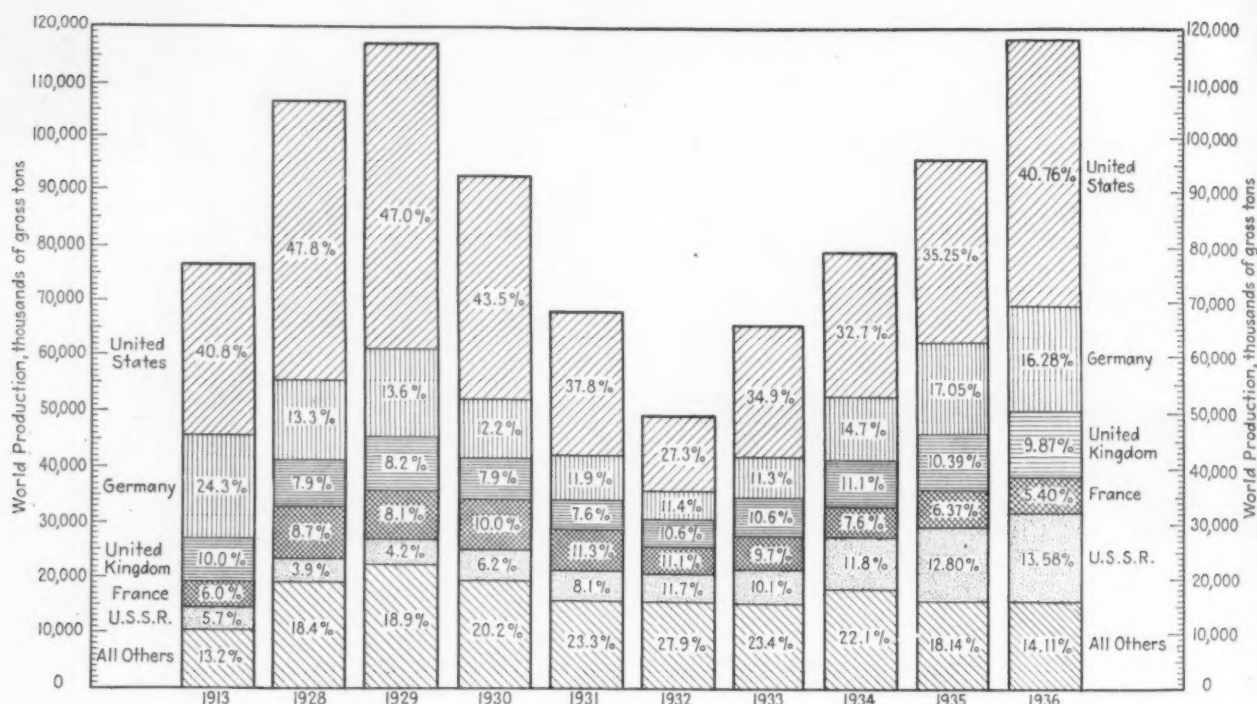
France, the world's fifth largest steel producer, barely exceeded her 1935 tonnage during 1936, production of steel ingots and castings for the past year being estimated at 6,400,000 tons. A political upheaval, the nationalization of some key industries, a widespread wave of strikes, a shortening of work days and adverse money exchange all served to inhibit an expansion in steel production, which otherwise would undoubtedly have followed the general upward trend in world production to a greater extent.

Belgium and Luxemburg, like France, only slightly exceeded 1935 production during 1936. For most of 1936, several of the more important Belgian iron and steel companies were laboring under a 40 per cent increase in loan payments to Dutch and French banks, resulting from the devaluation of

the belga in March, 1935. Prices had to be advanced and this discouraged much business. With the devaluation of the French franc and the Dutch florin late in 1936 these additional costs were wiped out, but the change came too late to help Belgian exporters regain in 1936 much of the important export business lost earlier in the year.

Japan, the world's seventh largest producer, had an estimated ingot and castings output of 4,230,000 tons in 1936. This nation continues steadily to expand steel-making facilities like Russia, only on a smaller scale. The industry benefited materially during the year from rising military requirements and heavy export demand. Japan now considers herself self-sufficient regarding steel, and imports in the future will be necessary only in cases of national emergency. A number of new open hearths and several new blast furnaces are scheduled to go into operation during 1937.

There is still a continued tendency for smaller countries to become producers of steel rather than be totally dependent on im-



World production of Steel Ingots and Castings—Percentage of Total for Leading Producers

ports. Turkey is the latest country to take this action. A contract has been signed with an English concern for the erection of a \$15,000,000 plant at Karabuk, near the iron mines of Sofranboli and within easy reach of the Turkish coal fields on the Black Sea coast. The plant, the first of its kind in Turkey, will have an annual output of 150,000 tons.

Italy, an insignificant producer of steel as compared with other

steel-producing countries, is estimated as having a 1936 output of 690,000 tons of ingots and castings. This estimate, however, is likely to be at considerable variance with true production, for Italy, following the example set by Germany in the early '20's, has since last autumn suspended all official statistics on production, imports of ore, scrap, etc.

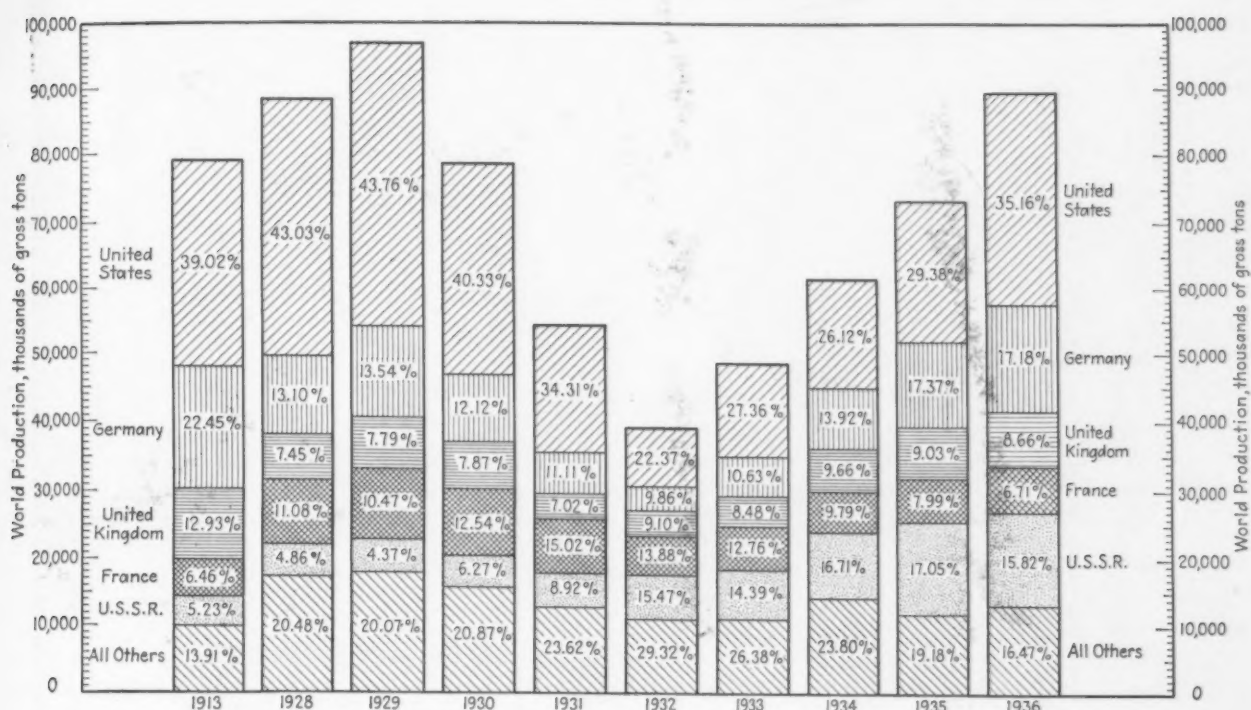
The world's six leading steel producers not only turned out more

finished steel in 1936 than in 1935, but these increases outstripped population increases in each case. In the United States, per capita consumption of finished steel rose from 446 lb. in 1935 to 586 lb. in 1936; in Germany the rise was from 318 to 384 lb.; per capita consumption in Great Britain advanced from 269 lb. in 1935 to 382 lb. in 1936; Belgium and Luxembourg were next with an increase from 242 lb. in 1935 to 375 lb. in

WORLD PRODUCTION OF STEEL INGOTS AND CASTINGS (Thousands of Gross Tons)

	1913	1928	1929	1930	1931	1932	1933	1934	1935	1936†
United States .....	31,301	51,544	56,433*	40,699	25,945	13,681	23,232	26,055	34,093	48,330
Germany .....	18,632	14,285	15,989	11,354	8,159	5,678	7,490	11,694	16,160	19,300*
Russia (U.S.S.R.) .....	4,365	4,183	4,923	5,769	5,524	5,827	6,726	9,394	12,211	16,100*
United Kingdom .....	7,664	8,520	9,636	7,326	5,203	5,261	7,024	8,860	9,850	11,700*
France .....	4,612	9,348	9,544*	9,296	7,697	5,550	6,426	6,052	6,166	6,400
Japan .....	240	1,923	2,206	2,212	1,821	2,315	3,084	3,754	3,900	4,230*
Belgium .....	2,428	3,843	4,044*	3,300	3,055	2,745	2,687	2,901	2,980	2,880
Italy .....	920	1,928	2,088	1,704	1,386	1,374	1,742	1,821	1,900	††
Luxembourg .....	1,312	2,526	2,659*	2,234	2,002	1,925	1,815	1,901	1,808	1,960
Czechoslovakia .....	††	1,704	2,111*	1,807	1,504	640	693	935	1,178	1,460
Saar .....	**	2,040	2,174*	1,904	1,513	1,440	1,649	1,921	**	**
Poland .....	1,575*	1,410	1,355	1,217	1,020	542	804	831	930	1,125
Canada .....	1,042	1,235	1,380*	1,012	702	335	410	759	929	1,080
Sweden .....	582	567	683	601	530	520	620	848	905	935
Spain .....	238	765	966*	859	594	523	450	502	540	390
All other countries .....	1,690	1,730	2,320	1,960	1,760	1,490	1,600	2,070	2,300	1,360†
<b>Total .....</b>	<b>76,601</b>	<b>107,551</b>	<b>118,511</b>	<b>93,254</b>	<b>68,415</b>	<b>49,846</b>	<b>66,452</b>	<b>80,398</b>	<b>95,850</b>	<b>119,550</b>

\*Highest yearly production. \*\*Included in Germany. †Estimated. ††Part of Austria-Hungary. ‡India and Australia account for about half this total. ‡‡Italian official statistics suspended since autumn, 1935; output estimated at 2,300,000 tons.



World Production of Pig Iron—Percentage of Total for Leading Producers

1936; French production lagged during the year, consequently per capita consumption advanced only slightly, from 193 lb. in 1935 to 205 lb. in 1936; in the U. S. S. R., a very large rural population with low standards of living, keeps her capita consumption figures low despite rapid advances in production, the comparative figures for the two years being 130 lb. in 1935, against 151 lb. in 1936; Japan's figure likewise is kept low by large sec-

tions of population too poor to buy steel products, the comparative per capita figures for 1935 and 1936 being 88 and 95 lb., respectively.

The per capita figures just listed are compiled from production records of finished steel, with due allowances made for exports and imports. However, these figures are at best approximations, for no provision can be made for invisible exports and imports, that is, fin-

ished steel which crosses boundaries in the form of manufactured articles and, therefore, do not show up in steel statistics. All the countries just mentioned, except the U. S. S. R., are large exporters of finished steel products, and if due consideration could be given to the steel contained in these exports the per capita consumption figures would undoubtedly undergo considerable alteration.

WORLD PRODUCTION OF PIG IRON (Thousands of Gross Tons) (Including Charcoal Iron and Ferro-Alloys)

	1913	1928	1929	1930	1931	1932	1933	1934	1935	1936†
United States .....	30,966	38,156	42,614*	31,752	18,426	8,781	13,346	16,139	21,373	31,310§
Germany .....	17,820*	11,615	13,187	9,540	5,966	3,870	5,183	8,602	12,641	15,300
Russia (U.S.S.R.) .....	4,149	4,308	4,251	4,937	4,793	6,074	7,019	10,327	12,400	14,090*
United Kingdom .....	10,260*	6,610	7,589	6,192	3,773	3,574	4,136	5,969	6,426	7,710
France .....	5,124	9,821	10,198*	9,874	8,068	5,448	6,223	6,063	5,708	5,970
Belgium .....	2,445	3,795	3,976*	3,311	3,147	2,705	2,667	2,860	3,013	3,100
Luxemburg .....	2,507	2,726	2,860*	2,433	2,020	1,929	1,858	1,924	1,843	1,960
Czechoslovakia .....	††	1,544	1,619*	1,417	1,146	443	491	590	799	1,065
Saar .....	**	1,905	2,071*	1,881	1,491	1,327	1,567	1,797	**	**
Poland .....	1,015*	670	698	470	341	196	301	380	389	550
Canada .....	1,015	1,083	1,169*	812	466	160	258	440	641	695
Sweden† .....	730	431	516	488	411	277	340	549	557	570
Italy .....	428	545	715*	572	533	481	545	564	625	§§
Japan .....	239	1,515	1,536	1,660	1,399	1,535	2,032	2,366	2,720	2,920*
Spain .....	418	556	741*	595	468	291	323	450	345	204
All other countries .....	2,250	3,390	3,648	2,862	1,664	2,171	2,482	3,065	3,290	3,300††
Total .....	79,366	88,670	97,383	78,726	53,712	39,262	48,771	62,075	72,770	89,434

\*Highest yearly production. \*\*Included in Germany †Estimated. ††Part of Austria-Hungary. ‡Highest yearly production = 842 in 1917. §§India and Australia account for about half this total. ¶Does not include charcoal pig iron. §§Italian official statistics suspended since autumn, 1935; output estimated at 690,000 tons.



**B**UILDING up the door at a South Chicago open hearth of the Carnegie-Illinois Steel Corp.

o o o

# ***WAGE***



THE first prehistoric employer who was polite enough to pay for other men's services, instead of commandeering them, must have corrugated his shaggy brow many times over this question, "Should I pay by time or by quantity?" and it has been wrinkling employer foreheads ever since.

Paying for services by the hour, day or week is the oldest, simplest and most widely used method of compensation. Departures from it are the exception. In many cases

the character of the work makes it the only feasible method. But where work is repetitive and measurable, payment by quantity frequently produces results favorable to employee and employer alike.

The first 25 or 30 years of this century saw a steady increase in the use of quantity payment systems, both piece work and production bonus and premium plans. The depression halted the march, for a requisite of quantity wage systems is a fairly steady flow of work, which was largely lacking in the lamented early '30's.

But the industrial picture has changed. Instead of worrying whether he has enough work to keep the plant running until the end of the week, the manufacturer may now be concerned with meeting delivery schedules. Has the improvement in business been accompanied by an expanding use of wage incentives in the industry making metal products? To answer this question, THE IRON AGE surveyed a cross-section of the industry.

A representative group of manufacturers of metal products oper-

By ARTHUR H. DIX  
*The Iron Age*

# INCENTIVES

ating large, medium-size and small plants, was asked to report on its present compensation methods and contemplated changes. Question No. 1 was, "What method of compensation are you now using?" A tabulation of the replies follows:

	Percentage of plants
Time rates exclusively .....	56
Time rates and piece work rates.	28
Time rates, production bonuses and piece work rates.....	12
Time rates and production bonuses	4
Total .....	100

How this compares with the pre-

depression status, it is impossible to say, as comparable figures for the metalworking industry are not available. However, the National Industrial Conference Board surveyed the general industrial field early in 1935 as to wage payment methods in use then as compared to 1924, with this result:

	Percentage of Wage Earners	
	1935	1924
Time rates .....	56.3	56.1
Piece rates .....	22.1	36.6
Premium and bonus sys- tems .....	21.6	7.3

THE IRON AGE survey is based on percentage of plants, while the



**R**EMOVING the scum from the top of an ingot during the "rimming" period.

Conference Board's survey covers percentage of wage earners. Therefore, the closeness of the figures opposite time rates is merely coincidental. The Conference Board's investigation shows that in industry as a whole the pre-depression and post-depression proportions of wage earners on time rates are almost identical, while the piece work rate percentage has declined sharply, with an almost equivalent rise in the proportion of wage earners included in premium and bonus systems.

But to return to THE IRON AGE survey. The next question asked was, "If you use both time rates and piece work rates or other wage incentives, what proportion of your employees is on time rates?" The answer:

	Percentage of Plants
From 1 to 20 per cent of employees on time rates .....	17.5
From 21 to 40 per cent of employees on time rates.....	40.0
From 41 to 60 per cent of employees on time rates .....	15.0
From 61 to 80 per cent of employees on time rates.....	20.0
Above 81 per cent of employees on time rates .....	7.5
Total .....	100.0

In plants using both time rates and wage incentives the average proportion of employees on time rates is approximately one-half or 51 per cent.

Question No. 3: "If you are now using piece work rates or other wage incentives are you employing them to an increasing or decreasing degree?" The answer:

	Percentage of Plants
No change .....	70
Increasing .....	27
Decreasing .....	3
Total .....	100

### Price Rates Predominate

The present trend is definitely toward a wider use of wage incentives, predominantly piece rates.

Although Question No. 3 was addressed only to those plants now employing incentives, many manufacturers who now use time rates exclusively and who are therefore not included in the foregoing table report:

"Propose to swing over to piece work plan in 1937. Business has come to a point where we believe it cannot pay fixed wages except for production. Costs must be subject to adequate control."

"Sometime in future we may install bonus systems, both individual and group."

"Planning to use group bonuses and to pay a bonus on company earnings."

"Contemplate going to piece work on some operations."

"Considering wage incentive of some type at the present time."

One-sixth of the plants covered by the survey use production bonus or premium systems. They were asked, "Do you pay individual bonuses, group bonuses, or both?" The answer:

	Percentage of Plants
Individual bonuses .....	40
Both individual and group bonuses .....	33
Group bonuses .....	27
Total .....	100

The foregoing table refers to production bonuses or premiums paid for bettering an established standard of output. The concluding question applies to a different type of bonus, "Is a bonus paid on company earnings?" The answer:

	Percentage of Plants
No bonus paid on company earnings .....	88
Bonus is paid on company earnings .....	12
Total .....	100

### Bonuses Paid by Many

In addition, several manufacturers report that a bonus is paid to foremen, but not to wage earners generally. The proportion of manufacturers paying a general bonus on company profits seems surprisingly high, equaling almost one-eighth of the plants reporting. Whether this is representative of

industry as a whole, no one can say. Companies to which the questionnaire was mailed were selected at random from THE IRON AGE subscription list. No one branch of the industry was emphasized or neglected. Selectivity was employed only to provide a fair geographical distribution. But, bearing in mind the dismal experience of another publisher who conducted a straw vote, we will not swear to the correctness of the returns as applied to the entire industry.

Entirely apart from the economic aspects of general bonuses on earnings and other profit-sharing plans is the question of their efficacy as production stimulants in the case of the average wage earner. Perhaps the reward is too remote to produce the full effect that is sought. Immediacy of reward is the priceless ingredient of the incentive tonic.

The piece rate is the traditional and most commonly employed form of production incentive. The survey reveals that 40 per cent of the plants reporting use piece rates, while 16 per cent pay production bonuses. These two percentages are not mutually exclusive, for as shown in table on page 151 there is a certain amount of overlapping. The survey does not indicate numerically whether the piece rate is losing ground among manufacturers of metal products from a long range viewpoint, as it seems to be in the general industrial field, judging from the results of the National Industrial Conference Board's survey. But so far as the immediate trend is concerned, the survey reveals that the reverse is the case. Typical comments from users are:

"We like and believe that piece work is the fairest to both operator and employer except in the case of some automatic machines."

"Some of our union men have asked that we discontinue our piece work system. We say, 'No.'"

#### Unions Favor Time Rates

Labor unions as a whole favor time rates and are bitterly opposed to incentive plans. But time rates *per se* are not fairer than quantity rates. The former are unjust when men of differing abilities and productivity receive the same compensation. From the employer's viewpoint, a frequently voiced criticism of time rates is that the output of a group tends to approximate that of the poorest producer.

Quantity payments, properly applied, reward the capable, industrious worker and the shirker each in his proper measure.

Objections to wage incentives as production stimulants are based on their abuse, and not without reason, for they can be harmfully applied. If a man is encouraged, or even permitted, to drive himself beyond his physical and nervous limits, the compensation method is wrong. But where this evil exists, charge it to prostitution of sound aid to industrial economy, rather than to an inherent fault in the method itself.

The cardinal sin in operating an incentive system is to cut a rate. If a bogey is set up it should be hewed to through hell and high water, as long as the design of the part made and the equipment used remain unchanged. Should the

employer take advantage of the increased output made possible by the introduction of the incentive system, and establish the new level as the normal, meanwhile making the reward point more difficult of attainment, he destroys his employees' faith in his fairness and in the incentive system, and places himself directly in line for labor troubles.

Where the seeds of rate cutting are sown the weeds of deliberately limited output flourish. "Don't make more than so many a day, or they'll cut the rate again."

#### Accurate Time Studies Needed

The words, "Be sure you're right, then go ahead," were never more truly spoken than when applied to the setting of standards on which incentive rates are based. If you lack the facilities to make

FOLLOWING the progress of a heat in the open-hearth furnace. This and the preceding illustrations are from the South Chicago works of Carnegie-Illinois.





**B**UILDING up the door at a South Chicago open hearth of the Carnegie-Illinois Steel Corp.

o o o

# WAGE



THE first prehistoric employer who was polite enough to pay for other men's services, instead of commandeering them, must have corrugated his shaggy brow many times over this question, "Should I pay by time or by quantity?" and it has been wrinkling employer foreheads ever since.

Paying for services by the hour, day or week is the oldest, simplest and most widely used method of compensation. Departures from it are the exception. In many cases

the character of the work makes it the only feasible method. But where work is repetitive and measurable, payment by quantity frequently produces results favorable to employee and employer alike.

The first 25 or 30 years of this century saw a steady increase in the use of quantity payment systems, both piece work and production bonus and premium plans. The depression halted the march, for a requisite of quantity wage systems is a fairly steady flow of work, which was largely lacking in the lamented early '30's.

But the industrial picture has changed. Instead of worrying whether he has enough work to keep the plant running until the end of the week, the manufacturer may now be concerned with meeting delivery schedules. Has the improvement in business been accompanied by an expanding use of wage incentives in the industry making metal products? To answer this question, THE IRON AGE surveyed a cross-section of the industry.

A representative group of manufacturers of metal products oper-

By ARTHUR H. DIX  
*The Iron Age*

# INCENTIVES

ating large, medium-size and small plants, was asked to report on its present compensation methods and contemplated changes. Question No. 1 was, "What method of compensation are you now using?" A tabulation of the replies follows:

	Percentage of plants
Time rates exclusively .....	56
Time rates and piece work rates. 28	
Time rates, production bonuses and piece work rates.....	12
Time rates and production bonuses	4
Total .....	100

How this compares with the pre-

At one time, not so many years ago, the trend was away from incentive pay plans based on production and toward time rates. Now the trend has been reversed.

depression status, it is impossible to say, as comparable figures for the metalworking industry are not available. However, the National Industrial Conference Board surveyed the general industrial field early in 1935 as to wage payment methods in use then as compared to 1924, with this result:

	Percentage of Wage Earners	
	1935	1924
Time rates .....	56.3	56.1
Piece rates .....	22.1	36.6
Premium and bonus systems .....	21.6	7.3

THE IRON AGE survey is based on percentage of plants, while the



**R**EMOVING the scum from the top of an ingot during the "rimming" period.

Conference Board's survey covers percentage of wage earners. Therefore, the closeness of the figures opposite time rates is merely coincidental. The Conference Board's investigation shows that in industry as a whole the pre-depression and post-depression proportions of wage earners on time rates are almost identical, while the piece work rate percentage has declined sharply, with an almost equivalent rise in the proportion of wage earners included in premium and bonus systems.

But to return to THE IRON AGE survey. The next question asked was, "If you use both time rates and piece work rates or other wage incentives, what proportion of your employees is on time rates?" The answer:

	Percentage of Plants
From 1 to 20 per cent of employees on time rates .....	17.5
From 21 to 40 per cent of employees on time rates.....	40.0
From 41 to 60 per cent of employees on time rates .....	15.0
From 61 to 80 per cent of employees on time rates.....	20.0
Above 81 per cent of employees on time rates .....	7.5
Total .....	100.0

In plants using both time rates and wage incentives the average proportion of employees on time rates is approximately one-half or 51 per cent.

Question No. 3: "If you are now using piece work rates or other wage incentives are you employing them to an increasing or decreasing degree?" The answer:

	Percentage of Plants
No change .....	70
Increasing .....	27
Decreasing .....	3
Total .....	100

### Price Rates Predominate

The present trend is definitely toward a wider use of wage incentives, predominantly piece rates.

Although Question No. 3 was addressed only to those plants now employing incentives, many manufacturers who now use time rates exclusively and who are therefore not included in the foregoing table report:

"Propose to swing over to piece work plan in 1937. Business has come to a point where we believe it cannot pay fixed wages except for production. Costs must be subject to adequate control."

"Sometime in future we may install bonus systems, both individual and group."

"Planning to use group bonuses and to pay a bonus on company earnings."

"Contemplate going to piece work on some operations."

"Considering wage incentive of some type at the present time."

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**F**OLLOWING the progress of a heat in the open-hearth furnace. This and the preceding illustrations are from the South Chicago works of Carnegie-Illinois.



accurate time studies, it is far better to set the initial production standard of output high enough to allow a margin of downward revision if necessary, than to estimate too low, and find yourself in the embarrassing position of being obliged to explain to a supervisor why men under him are earning more than he does. Nothing is so calculated to create dissatisfaction as failure to maintain proper intra-plant compensation differentials. The skilled die maker, who can hardly be included in an incentive system, will become exceedingly vocal if his weekly pay envelope is smaller week after week than that of the press operator.

In initiating a wage incentive plan, present daily average output provides you with a rough-and-ready standard on which incentives may be calculated. Practically all incentive systems assure the average wage earner that he will make no less than he earned under time rates, and perhaps more. Therefore, if you take present output as a base and pay a premium for exceeding that base, as is done in the case of the Halsey system, which is one of the oldest and most elementary premium plans, you and the wage earner have much to gain and little to lose.

Of course, it is all not as simple as that. While the goal is attractive, the path to a satisfactory wage incentive system is not flanked with primroses. At the outset you may expect a certain amount of objection on the part of your employees, who naturally distrust the unknown. But if they have faith in you, reinforced by a taste of higher income, that obstacle can be hurdled successfully.

Next, if operators do not work



**M**ANPOWER is the real power back of industry and of industrial accomplishment. What is the best and fairest way to compensate it for its services?

o o o

on the same part day in and day out, and if some jobs are looked upon as "easy," and others "hard,"



as they undoubtedly will be no matter how conscientiously you strive to establish fair rates, you will be called upon to iron out disputes arising from charges of favoritism in dispensing work. But this is one of management's permanent burdens, and is not unbearable.

Again, causes beyond the control of the operator—lack of material, defective material, breakdown of a machine, or some other mishap—may cut the output. If you use an incentive plan with an assured daily rate, the operator makes his day's pay anyway. If he is on piece rates, you may transfer him to time rates for the day; although some plants make no allowance for interruptions, treating the loss as mutual.

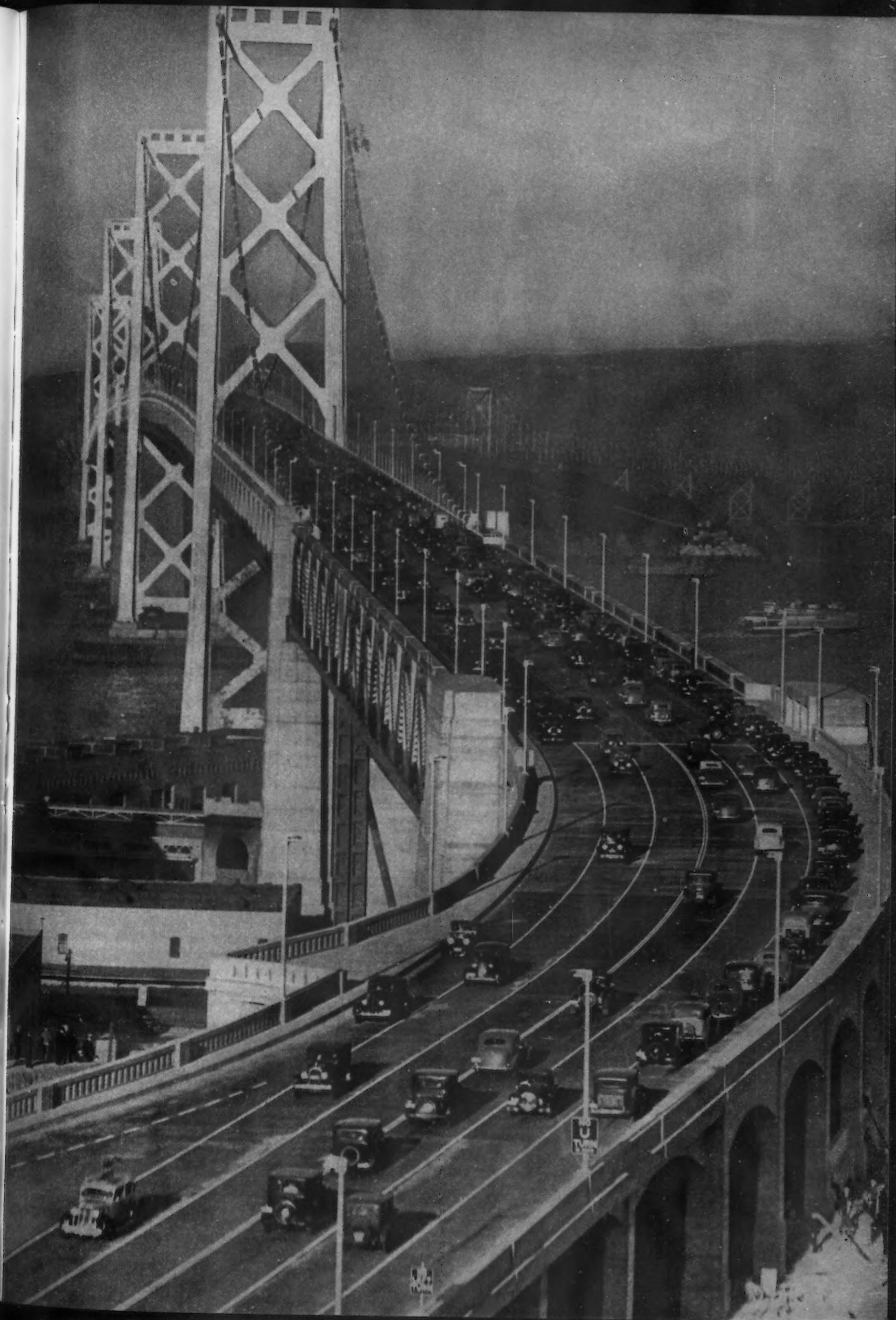
You need not dive headlong into the incentive pond. It is far better to try incentives on a few operations at a time, learn as you go along, and make your mistakes on a small scale. Your clerical expense will doubtless advance somewhat, and so may inspection costs, but supervision expense will probably shrink. Your ultimate cost figures will show something in your favor and your employees' pay envelopes will be fatter, that is, if your experience agrees with that of the majority who use wage incentives.

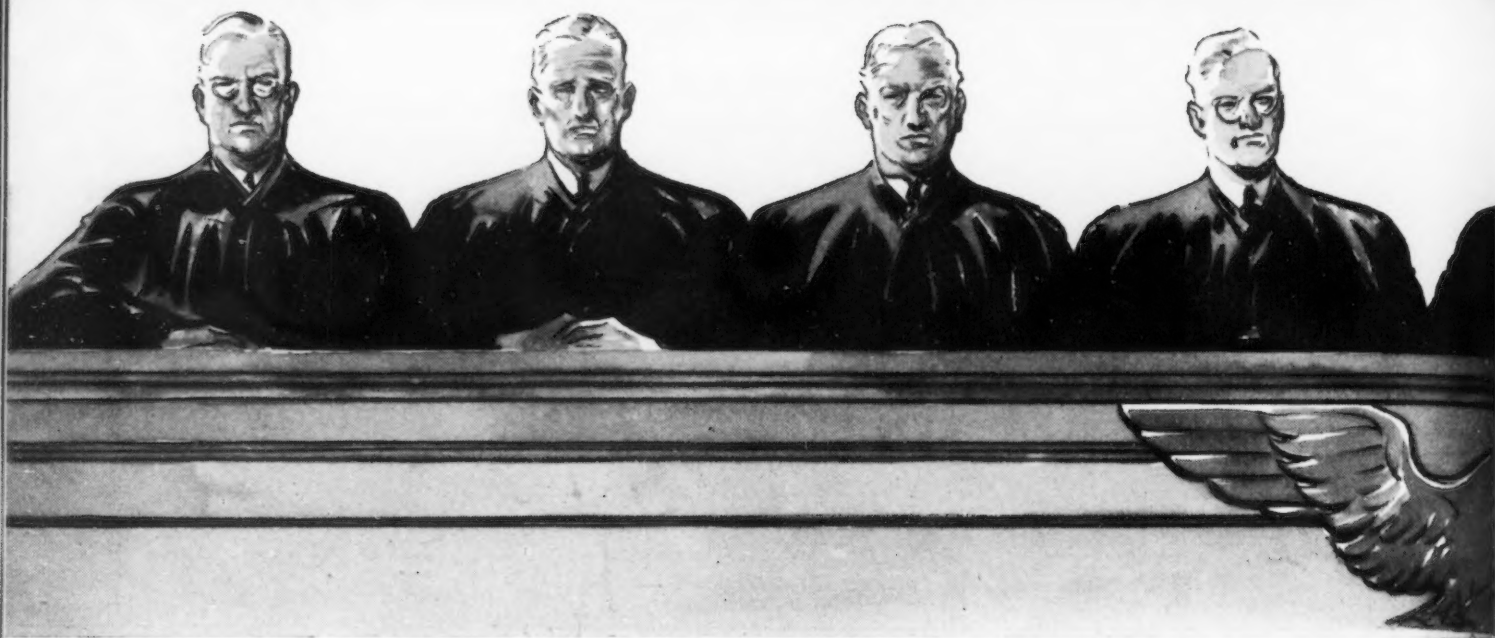
As industry becomes more highly mechanized, the field of application for wage incentives will doubtless diminish, for there is little point in placing an incentive on an operation over which the worker has little control. But in the average plant the human element still governs production costs. Therefore, it is safe to assume that the obstacle in the way of a wider use of incentives is not inapplicability but inertia.

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**F**OR 65 cents, a California motorist can rent the use of this \$77,600,000 bridge. From end to end, the recently completed San Francisco-Oakland Bay bridge measures 8½ miles; the longest bridge in the world, by far.

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# LEGISL

*Prospective laws that new Congress may adopt include some that failed at last session.*

• • •

FROM the outlook, at this stage of business recovery, prospective legislation by the Seventy-fifth Congress appears likely to fall into two classes: Acts to revive some of those which died in the last Congress and acts to amend or replace laws which will not work or which may be declared invalid, in whole or in part, by the Supreme Court.

In the first class are such measures as a substitute Guffey Bill, possibly extended to include bituminous as well as anthracite coal, and intended to regulate the rate of pay and hours of labor in those fields by law. This is a principle to which the Administration is wholly committed and which it will effectuate, if it must initiate a constitutional amendment to do so.

One of the State minimum wage laws, that of the State of Washington, with respect to women is on the

Supreme Court docket for test. The New York Women's Wage Law, found invalid by a United States District Court, may be tested by the State before the Supreme Court. It is likely, therefore, that new legislation re hours and wages will await the Court's ruling.

After the ruling, however, a flood of labor legislation is to be expected. The natural disposition of the Administration has been to play up to labor and, while the Executive, perceiving the dangers of labor domination, has begun to tread more cautiously, the Congress will plunge ahead in full career, with a mass of labor bills. Fortunately most of them will die a-bornin'. They usually do. The Speaker of the House, the party whips and the real leaders will see to that.

## Bills That May Be Passed

Some of the bills, which will undoubtedly be brought up and which will have a fair chance of enactment are: The Ellenbogen Little NRA imposing hours and wages upon the textile industry; the Connerly bill, which the Chairman of

the House Labor Committee has ready, establishing a 30-hr. week; an amendment to the Walsh-Healey Government Contracts Act in response to the demand of labor that the textile industry be not excepted; the Van Nuys bill forbidding employers to influence the votes of their employees in national elections.

If the Wagner Act, now before the Supreme Court, is found invalid in its essentials, some other bill to enact the principle of guaranteeing the right of collective bargaining will be introduced. The Senate Committee on Education and Labor will probably continue to be headed by Senator Black. The character of legislation which may be expected from that source is indicated by the Black bill, which died in the last Congress. It aimed



# L ATION

By MORGAN FARRELL

Director Chilton Bureau of  
Economic Research

**Measures to replace  
those declared un-  
constitutional are  
also likely to be  
passed.**

to prohibit the shipment in interstate commerce of any article produced by employees required to work more than 30 hr. a week.

Another piece of labor legislation, which will eventually put in an appearance, though perhaps not at the coming session, is an amendment to the Social Security Act, by which the employees' share of the tax will be shifted to the employer. The act itself will doubtless be considerably overhauled by the next Congress, if it escapes drastic treatment by the Supreme Court, which seems likely. The fiscal provisions are now generally recognized to lodge a perilously large volume of borrowing power with the Government, without sufficiently definite limitation as to its use.

It is probable that the Administration will be able to observe its

pledge of no more taxation in 1937 because there are no extraordinary expenses in sight. Nor are the present revenue acts likely to be set aside, requiring new tax legislation. To be sure, the Surplus Tax Act will almost certainly be amended to permit a certain exemption of surplus from taxation to permit capital expenditures for plant and equipment purchase or modernization. In fact, Senator Robinson and others have already announced that they will introduce such an amendment.

In early December a Federal District Court in Virginia granted a temporary injunction to the Rapidan Milling Co. and the Mine Run Dollar Mills, restraining N. B. Early, collector of internal revenue, from collecting the tax on "unjust enrichment"—or windfall. Other cases are up before other courts. On Dec. 14 another district court upheld the windfall tax in an Indiana suit. The U. S. Supreme Court has yet to rule on it. If it fails, substitute laws may be expected.

A number of temporary tax measures expire July 1. Among them

are taxes on gasoline, radios, mechanical refrigeration, automobiles and the 3c. postage rate. They will be renewed. With a 7½ billion dollar budget to balance and the Post Office showing a deficit even with a 50 per cent advance in first-class postage, there is not much doubt of that.

## New Patman Bill May Pass

In addition to labor and tax measures, there is a great number of miscellaneous bills, of importance to business, which could not get through the last crowded session but will surely be brought up in the next. Among them are: The O'Mahoney bill requiring all business operating across State lines to secure a Federal license; the Wheeler-Rayburn bill, greatly expanding the powers of the Federal Trade Commission; the Copeland Merchant Marine bills having to do mostly with subsidies, construction specifications and marine labor. Finally there is a new Patman bill, which that Representative has announced he will introduce. It is aimed to put the manufacturer out of the retail selling business and

vice versa. There is little doubt about its passage, since it is in line with the Administration's avowed policy of protecting the "little fellow."

The Copeland amendments to the Pure Food, Drug and Cosmetic Act were lost in the House last year, but are bound to be revived in more acceptable form. The St. Lawrence Waterway Treaty will be brought up in the Senate once more. The Maritime Commission's inability to handle the longshoremen's and seamen's strike will doubtless lead to some new legislation. Can it be that the law will be given teeth? We doubt it.

Meanwhile the Electric Farm and Home Authority's power to finance the sales of domestic and farm electrical appliances dies on Feb. 1 and may not be renewed. The Neutrality Act expires on May 1 and the Connelly Hot Oil Act on June 16. Both will most likely be renewed, though in amended form.

The Reconstruction Finance Corporation seems likely to crown a fine achievement by liquidating as planned, when its usefulness is over. Stream pollution regulation, which failed in the recent session, will be up again, to pass in greatly modified form, probably as a mere authorization for the Bureau of the Public Health Service to cooperate with State and municipal agencies.

The Securities Exchange Commission wants authority to act in corporate bankruptcies; the Secretary of Agriculture wants to investigate traffic conditions; the Secretary of Labor wants to make a study of labor-saving devices and their effect on employment, and the Secretary of Commerce wants to make a study of unemployment at a cost of 20 million dollars. All will probably have their wants granted.

#### Cases Before Supreme Court

In the other class of possible future legislation are the substi-

tutes for some but not all the measures now on the docket of the Supreme Court. Here is a résumé prepared by the Chamber of Commerce of the United States of the important cases to be heard by that tribunal:

1. National Labor Relations Act. Bradley Lumber Co. seeks to enjoin the National Labor Relations Board from attempts to force re-employment of discharged employees.

2. Railroad Labor Act. Virginian Railway sued to enjoin the collective bargaining provisions of the 1934 Railway Labor Act.

3. PWA loans for competing utility plants. Duke Power Co. and, in another case, three utilities seek to test right of PWA Administrator to lend funds for county and municipal plants.

4. Amended Frazier-Lemke Farm Mortgage Act. Two cases testing the constitutionality of the Act.

5. Arms and Munitions Resolution. Curtiss-Wright claims resolution cannot be applied to the Chaco.

6. Gold Clause. Test by Holyoke Water Power Co. of efficacy of gold clause in an 1880-1898 power contract.

7. New York Mortgage Moratorium Law. Constitutionality challenged.

8. North Carolina Mortgage Law. Constitutionality of law against deficiency judgments challenged.

9. Silver Purchase Act. Retroactive tax feature of act challenged.

10. New York Unemployment Insurance Act. Two cases. State Court of Appeals upheld act.

11. Securities Exchange Commission. Two cases, one re right to summon witnesses, while refusing access to records; the other to void a voluntary injunction.

12. Federal Communications Commission. American Telephone & Telegraph Co. opposes commission's order requiring uniform ac-

counting systems for telephone companies.

13. Texas Oil Proration Law. Act to prevent waste by prorating oil which may be produced, challenged as unconstitutional.

14. Shipping Board Bureau. Isbrandtsen-Moller Co. says President could not be authorized to transfer board to Department of Commerce.

15. State Minimum Wage Law. Appeal from Washington (State) Supreme Court decision upholding law.

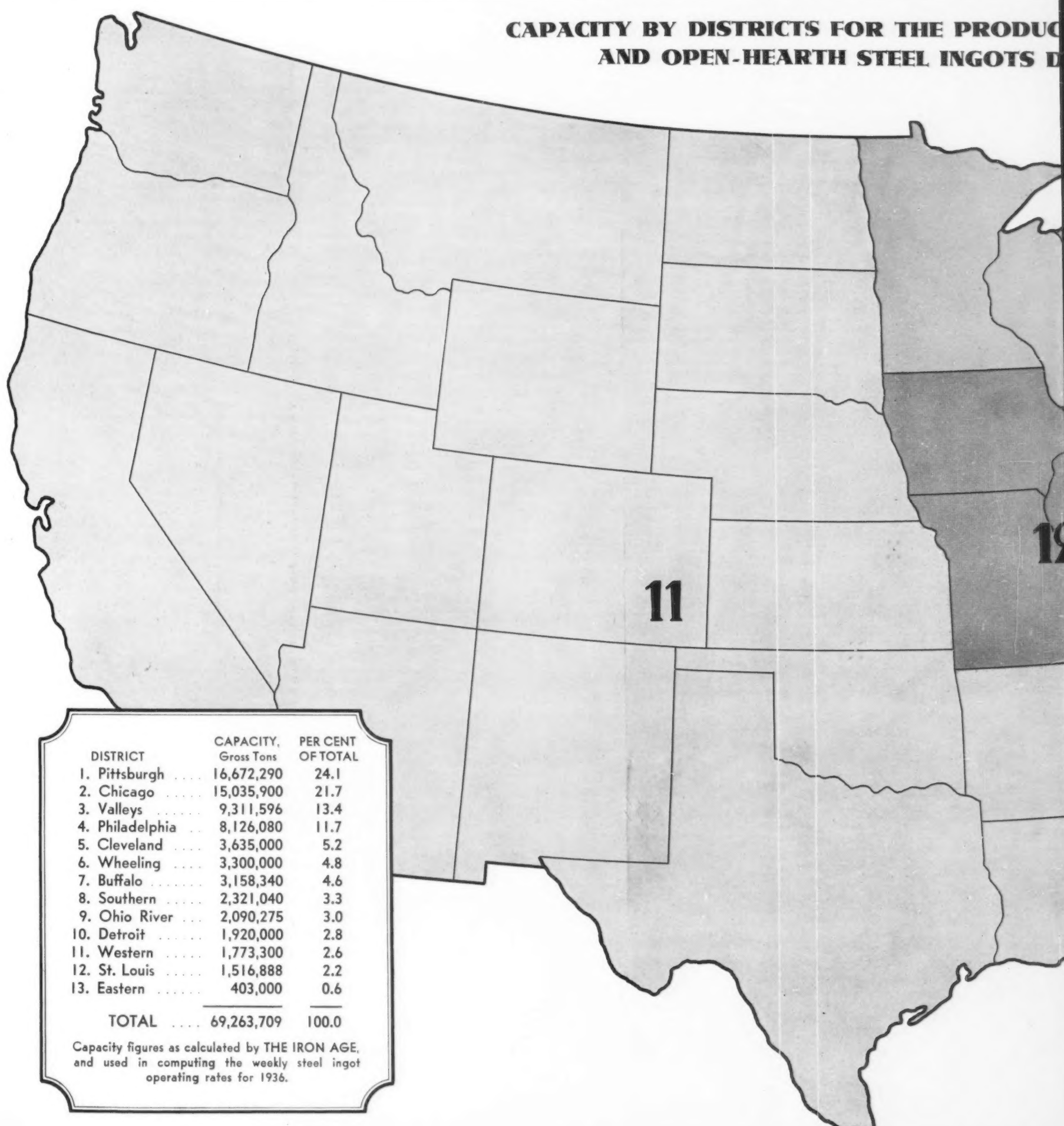
Of these cases all but 7, 8 and 13 involve basic policies of the Administration and so would, in all likelihood, be replaced by substitute legislation during the next session, provided, of course, that they are voided by the Supreme Court.

In the international field, it is expected that the authority given to the President to negotiate reciprocal trade agreements with other nations will be made permanent. The power delegated to him to fix the gold content of the dollar at not less than 50c., which also expires Jan. 30, 1937, will be renewed. Further devaluation, however, is considered improbable.

#### No Surprise Legislation Expected

This then is the general legislation expectation for the Seventy-fifth Congress. There seems to be no surprise legislation of a radical character in contemplation, which will have the sanction of the Administration. The apparent need for the kind of law-making, which produced the NRA, AAA and so many other alphabetical agencies, has passed with the depression. As the nation's business is once more bowling along with a fair wind (and a reef or two in the sails) it looks as though the Administration will be content to let her ride, meanwhile trying to make some of the present laws workable.

# CAPACITY BY DISTRICTS FOR THE PRODUCTION OF OPEN-HEARTH STEEL INGOTS DURING 1936



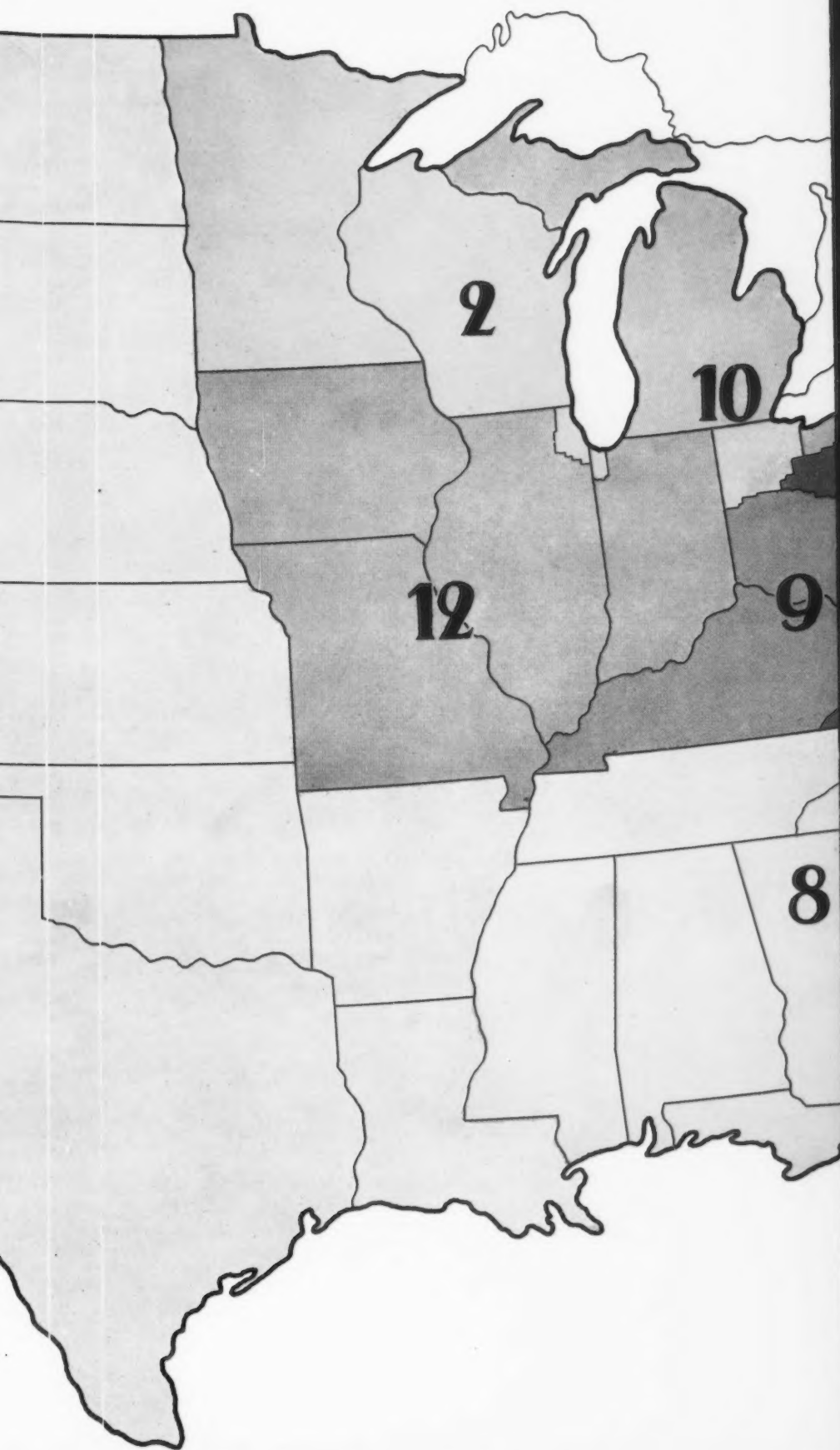
DISTRICT	CAPACITY, Gross Tons	PER CENT OF TOTAL
1. Pittsburgh . . . . .	16,672,290	24.1
2. Chicago . . . . .	15,035,900	21.7
3. Valleys . . . . .	9,311,596	13.4
4. Philadelphia . . . . .	8,126,080	11.7
5. Cleveland . . . . .	3,635,000	5.2
6. Wheeling . . . . .	3,300,000	4.8
7. Buffalo . . . . .	3,158,340	4.6
8. Southern . . . . .	2,321,040	3.3
9. Ohio River . . . . .	2,090,275	3.0
10. Detroit . . . . .	1,920,000	2.8
11. Western . . . . .	1,773,300	2.6
12. St. Louis . . . . .	1,516,888	2.2
13. Eastern . . . . .	403,000	0.6
<b>TOTAL . . . . .</b>	<b>69,263,709</b>	<b>100.0</b>

Capacity figures as calculated by THE IRON AGE, and used in computing the weekly steel ingot operating rates for 1936.

**CAPACITY BY DISTRICT  
AND OPEN-HEAD**



**DISTRICTS FOR THE PRODUCTION OF BESSEMER  
HEARTH STEEL INGOTS DURING 1936**



**Y BY DISTRICTS FOR THE PRODUCTION OF BESSEMER  
AND OPEN-HEARTH STEEL INGOTS DURING 1936**







# STATISTICAL SECTION

of THE IRON AGE

ANNUAL REVIEW NUMBER, JANUARY 7, 1937

## Steel Ingots Made in the United States

(THE IRON AGE figures prior to June, 1917; American Iron and Steel Institute figures since then, with additions for electric and crucible steel)  
(Thousands of Gross Tons)

	Jan.	Feb.	March	April	May	June	Half Year	July	Aug.	Sept.	Oct.	Nov.	Dec.	Second Half	Year
1900	979	868	962	893	977	921	5,600	798	775	685	712	698	727	4,395	9,995
1901	1,009	968	1,069	1,085	1,162	1,194	6,388	1,136	1,159	1,079	1,200	1,176	1,018	6,768	13,156
1902	1,223	1,060	1,192	1,256	1,321	1,185	7,237	1,189	1,211	1,209	1,268	1,174	1,268	7,319	14,556
1903	1,217	1,131	1,265	1,322	1,363	1,376	7,674	1,230	1,250	1,277	1,178	822	674	6,431	14,105
1904	759	1,020	1,239	1,325	1,263	1,100	6,706	885	1,001	1,153	1,196	1,262	1,327	9,913	19,463
1905	1,516	1,359	1,710	1,624	1,735	1,576	9,550	1,425	1,629	1,670	1,740	1,770	1,673	11,295	22,624
1906	1,928	1,746	2,018	1,848	1,986	1,833	11,329	1,739	1,794	1,757	2,047	2,029	1,929	10,737	22,559
1907	2,005	1,830	1,949	2,007	2,087	1,944	11,822	1,975	2,046	1,899	2,124	1,654	1,039	13,577	22,559
1908	934	954	1,057	1,023	1,004	972	5,944	1,049	1,171	1,263	1,401	1,350	1,499	7,733	13,577
1909	1,623	1,575	1,722	1,622	1,700	1,801	10,043	1,899	2,030	2,225	2,347	2,376	2,739	13,256	22,299
1910	2,404	2,257	2,506	2,365	2,503	2,157	13,892	1,904	2,016	1,956	1,929	1,818	1,639	11,262	28,154
1911	1,716	1,788	2,199	2,001	1,918	1,801	11,423	1,682	1,951	1,992	2,050	2,015	1,916	11,606	23,029
1912	2,169	2,191	2,441	2,491	2,648	2,461	14,401	2,445	2,648	2,484	2,833	2,759	2,715	15,884	30,285
1913	2,814	2,862	2,679	2,757	2,541	2,532	16,185	2,482	2,466	2,510	2,563	2,151	1,923	14,095	30,280
1914	1,907	1,881	2,287	2,285	2,039	1,930	12,329	1,907	1,944	1,895	1,799	1,470	1,476	10,491	22,820
1915	1,663	1,777	2,226	2,271	2,351	2,555	12,843	2,662	2,837	3,061	3,246	3,259	3,326	18,441	31,284
1916	3,333	3,321	3,627	3,356	3,652	3,473	20,762	3,245	3,481	3,463	3,672	3,581	3,198	20,640	41,102
1917	3,743	3,093	3,864	3,792	4,061	3,617	22,170	3,447	3,663	3,486	3,932	3,714	3,207	21,449	43,619
1918	2,641	2,725	3,728	3,791	3,939	3,696	20,520	3,732	3,696	3,532	4,017	3,668	3,586	22,531	43,031
1919	3,651	3,178	3,128	2,631	2,266	2,607	17,461	2,947	3,226	2,718	2,046	2,513	2,784	16,234	33,695
1920	3,624	3,402	3,917	3,132	3,423	3,539	20,937	3,328	3,562	3,561	3,581	3,133	2,779	19,944	40,881
1921	2,517	1,999	1,795	1,387	1,446	1,146	10,290	918	1,300	1,342	1,847	1,897	1,630	8,934	19,224
1922	1,893	2,071	2,814	2,902	3,219	3,128	16,027	2,953	2,629	2,818	3,410	3,430	3,301	18,541	34,565
1923	3,841	3,472	4,067	3,964	4,216	3,767	23,327	3,531	3,696	3,357	3,577	3,134	2,863	20,159	43,486
1924	3,650	3,326	4,207	3,348	2,640	2,066	19,737	1,878	2,553	2,828	3,125	3,121	3,569	17,074	36,811
1925	4,193	3,752	4,194	3,554	3,455	3,205	22,353	3,084	3,421	3,490	3,889	3,903	3,971	21,758	44,141
1926	4,132	3,785	4,469	4,106	3,928	3,734	24,154	3,635	3,987	3,913	4,074	3,706	3,467	22,782	46,936
1927	3,823	3,845	4,575	4,163	4,083	3,526	24,015	3,232	3,529	3,298	3,345	3,155	3,203	19,762	43,777
1928	4,028	4,081	4,549	4,345	4,240	3,778	25,027	3,841	4,217	4,186	4,693	4,306	4,055	25,298	50,325
1929	4,545	4,372	5,118	4,999	5,339	4,951	29,234	4,898	4,988	4,573	4,579	3,556	2,932	25,526	54,550
1930	3,808	4,067	4,288	4,142	4,014	3,445	23,764	2,945	3,085	2,863	2,714	2,230	1,905	15,831	39,695
1931	2,534	2,570	3,083	2,794	2,574	2,149	15,704	1,907	1,733	1,560	1,605	1,607	1,313	9,725	25,429
1932	1,500	1,496	1,448	1,273	1,137	923	7,777	815	856	1,003	1,099	1,043	871	5,687	13,464
1933	1,030	1,087	910	1,361	2,005	2,599	8,992	3,210	2,905	2,313	2,112	1,540	1,822	13,902	22,994
1934	2,025	2,243	2,836	2,476	3,447	3,102	16,629	1,509	1,399	1,286	1,502	1,633	1,991	9,320	25,949
1935	2,915	2,817	2,910	2,682	2,675	2,294	16,293	2,303	2,962	2,869	3,192	3,200	3,121	17,647	33,940
1936	3,046	2,964	3,343	3,942	4,046	3,985	21,326	3,923	4,195	4,161	4,545	4,337	*4,513	*25,674	*47,000

Figures for 1936 are preliminary and do not include electric and crucible ingots.

\*Estimated.

## Daily Production of Steel Ingots in the United States, Gross Tons

	Jan.	Feb.	March	April	May	June	First Half	July	Aug.	Sept.	Oct.	Nov.	Dec.	Second Half	Year
1900	36,244	36,173	35,648	35,732	36,180	35,422	35,899	31,929	28,719	27,394	26,384	26,831	29,071	28,356	32,139
1901	37,364	40,342	41,126	41,746	43,051	43,759	41,213	43,702	42,939	43,174	44,427	45,235	40,699	43,334	42,303
1902	45,284	44,164	45,834	48,321	48,939	47,419	46,693	45,735	46,569	46,497	46,974	46,961	48,760	46,916	46,805
1903	45,066	47,111	48,668	50,557	52,436	52,906	49,510	47,313	48,075	49,128	43,624	32,872	25,909	41,222	45,353
1904	29,186	40,817	45,863	50,973	48,567	42,309	42,985	35,416	37,057	44,339	45,985	48,542	51,064	43,744	43,364
1905	58,298	57,860	63,349	64,980	64,248	60,624	61,614	56,993	60,320	64,142	61,174	68,077	66,921	63,954	62,784
1906	71,406	72,758	74,746	73,942	72,439	70,500	72,626	69,491	66,501	70,295	75,823	78,023	77,161	72,869	72,747
1907	74,265	76,239	74,967	77,216	77,293	77,749	76,272	75,950	75,774	75,971	78,689	63,607	41,559	68,828	72,539
1908	34,617	38,153	40,675	39,342	38,605	37,375	38,105	40,342	45,034	48,561	51,903	53,997	57,654	49,568	43,839
1909	62,412	65,630	63,753	62,387	65,390	69,273	64,791	73,031	78,084	89,576	90,256	91,398	91,511	84,976	74,916
1910	92,462	94,024	92,804	90,097	84,720	82,977	89,624	76,152	4,678	75,242	74,191	69,946	63,015	72,195	80,881
1911	65,991	74,524	81,441	80,042	71,023	69,285	73,698	67,257	72,268	76,632	78,851	77,498	76,642	74,880	74,289
1912	80,320	87,650	93,879	95,803	98,066	98,439	92,310	94,057	98,060	99,369	104,927	106,107	108,610	101,223	97,066
1913	104,218	106,757	103,034	106,052	105,220	101,268	104,419	95,468	94,839	96,543	94,927	96,051	73,954	90,562	97,364
1914	70,630	78,348	87,972	87,887	78,410	74,239	79,539	73,350	74,759	72,589	66,625	58,786	56,794	67,251	67,376
1915	63,964	74,060	82,432	87,354	90,406	98,264	82,877	102,357	111,023	117,733	124,839	125,359	127,946	118,215	100,592
1916	128,195	132,824	134,334	134,239	135,277	133,563	133,089	129,780	128,943	133,184	141,224	137,739	127,934	136,162	133,125
1917	138,629	128,891	143,063	151,665	150,400	139,129	142,113	137,900	135,683	139,455	145,619	142,843	128,623	138,384	140,255
1918	97,822	113,539	143,370	145,815	145,910	147,814	132,322	143,520	136,875	153,289	148,794	141,083	143,445	144,430	138,425
1919	135,224	132,396	120,295	101,202	83,935	104,287	112,651	113,332	124,082	104,539	75,779	100,523	107,077	104,064	108,343
1920	130,519	141,739	145,073	120,480	131,661	136,114	134,213	127,992	137,016	136,976	137,726	120,496	106,874	127,546	131,090
1921	96,810	83,279	66,473	53,342	55,622	44,090	66,387	36,713	48,156	51,619	71,044	72,942	62,707	57,270	61,814
1922	72,764	86,324	104,247	116,090	119,215	120,229	103,401	118,112	97,380	108,395	131,164	131,935	132,071	119,621	111,511
1923	142,263	144,660	150,618	158,549	156,161	144,894	149,532	141,258	136,881	134,271	132,485	120,551	114,531	130,056	139,825
1924	135,182	153,050	161,796	128,787	97,779	82,627	126,519	72,223	98,188	108,755	115,756	124,846	137,279	109,449	117,984
1925	155,307	166,348	161,321	137,534	132,853	123,248	144,407	118,634	131,577	134,214	144,030	156,116	152,728	139,472	141,932
1926	158,931	157,710	165,504	157,915	151,076	143,621	155,831	139,807	153,347	150,515	156,713	142,529	133,339	146,039	150,920
1927	147,039	160,222	169,439	160,130	157,023	135,621	154,939	129,285	130,707	126,824	128,664	121,320	123,201	126,676	140,761
1928	154,913	163,231	168,475	173,505	157,298	145,325	160,429	153,629	150,192	167,447	173,810	165,624	162,212	163,209	161,818
1929	168,323	182,150	196,861	192,273	197,727	198,062	189,157	188,409	184,742	182,910	169,602	136,769	117,271	163,631	176,368
1930	141,035	169,452	164,915	159,300	148,676	137,817	153,317	113,277	118,648	110,105	100,508	89,185	76,735	101,482	127,316
1931	93,852	107,083	118,577	107,462	99,346	82,654	101,162	73,346	66,654	60,000	59,444	61,800	50,500	61,577	81,265
1932	57,690	59,840	53,630	48,970	43,730	35,500	49,850	32,600	31,700	38,580	42,270	40,110	33,500	36,455	48,153
1933	39,600	45,600	33,700	54,450	74,150	100,000	57,950	128,400	107,600	89,000	81,200	59,250	72,850	89,700	73,850
1934	74,981	93,427	105,066	119,562	127,632	119,284	106,585	60,394	51,862	51,454	55,637	62,796	79,646	79,460	83,400
1935	107,964	117,402	111,926	103,149	99,068	91,759	105,119	85,588	109,686	114,767	118,218	123,064	124,858	113,122	109,133
1936	112,813	118,577	128,562	151,625	155,625	153,263	136,707	150,874	161,351	160,043	168,333	173,496	173,496	164,572	150,044

## Pig Iron Production of the United States in Thousands of Gross Tons

(THE IRON AGE figures, including ferroalloys made in blast furnaces, but excluding charcoal iron)

	Jan.	Feb.	March	April	May	June	Half Year	July	Aug.	Sept.	Oct.	Nov.	Dec.	Second Half	Year
1900	1,285	1,158	1,264	1,226	1,282	1,215	7,430	1,132	1,018	939	935	920	1,031	5,975	13,405
1901	1,162	1,134	1,279	1,257	1,339	1,318	7,489	1,360	1,336	1,300	1,382	1,362	1,266	8,006	15,496
1902	1,428	1,258	1,445	1,475	1,543	1,447	8,595	1,442	1,468	1,419	1,481	1,433	1,537	8,780	17,375
1903	1,473	1,391	1,490	1,608	1,714	1,673	9,449	1,546	1,571	1,554	1,426	1,039	847	7,983	17,432
1904	924	1,208	1,451	1,561	1,537	1,296	7,977	1,121	1,173	1,358	1,455	1,487	1,616	8,210	16,187
1905	1,782	1,597	1,936	1,922	1,964	1,793	10,994	1,742	1,544	1,899	62,053	2,014	2,046	11,598	22,592
1906	2,069	1,904	2,165	2,073	2,097	1,977	12,287	2,013	1,927	1,971	2,197	2,188	2,235	12,531	24,818
1907	2,206	2,045	2,226	2,219	2,295	2,235	13,226	2,256	2,250	2,184	2,237	1,828	1,234	12,089	25,315
1908	1,045	1,078	1,228	1,150	1,166	1,092	6,759	1,218	1,360	1,419	1,567	1,578	1,741	8,883	15,642
1909	1,798	1,707	1,836	1,739	1,883	1,931	10,894	2,103	2,249	2,385	2,600	2,547	2,636	14,520	25,414
1910	2,609	2,397	2,618	2,484	2,390	2,265	14,763	2,149	2,107	2,066	2,093	1,910	1,778	12,093	26,856
1911	1,759	1,795	2,171	2,065	1,893	1,788	11,477	1,793	1,927	1,977	2,102	2,000	2,043	11,842	23,313
1912	2,058	2,101	2,405	2,375	2,513	2,441	13,893	2,411	2,512	2,464	2,690	2,631	2,782	15,490	29,383
1913	2,795	2,586	2,764	2,753	2,822	2,629	16,349	2,561	2,546	2,506	2,546	2,233	1,984	14,376	30,725
1914	1,885	1,888	2,348	2,270	2,093	1,918	12,402	1,958	1,995	1,883	1,778	1,518	1,516	10,648	23,050
1915	1,601	1,685	2,064	2,117	2,263	2,381	12,101	2,563	2,780	2,853	3,126	3,037	3,203	17,562	29,663
1916	3,185	3,087	3,339	3,227	3,361	3,211	19,410	3,224	3,204	3,202	3,509	3,312	3,178	19,629	39,040
1917	3,151	2,645	3,252	3,335	3,417	3,270	19,070	3,342	3,248	3,134	3,303	3,206	2,883	19,116	38,186
1918	2,412	2,319	3,213	3,288	3,447	3,324	18,003	3,421	3,389	3,418	3,487	3,354	3,434	20,503	38,506
1919	3,303	2,940	3,090	2,478	2,108	2,115	16,034	2,429	2,743	2,468	1,864	2,392	2,633	14,549	30,583
1920	3,015	2,979	3,376	2,739	2,986	3,044	18,139	3,067	3,147	3,129	3,293	2,935	2,704	18,275	36,414
1921	2,416	1,937	1,596	1,193	1,221	1,065	9,428	865	954	986	1,247	1,415	1,649	7,116	16,544
1922	1,645	1,630	2,036	2,072	2,306	2,361	12,050	2,405	1,816	2,034	2,639	2,849	3,087	14,530	26,880
1923	3,229	2,994	3,524	3,550	3,868	3,676	20,841	3,678	3,450	3,126	3,149	2,894	2,921	19,218	40,059
1924	3,019	3,075	3,466	3,233	2,615	2,026	17,434	1,785	1,887	2,053	2,477	2,510	2,962	13,674	31,108
1925	3,370	3,214	3,564	3,259	2,931	2,674	19,012	2,664	2,705	2,726	3,023	3,250	3,250	17,991	36,403
1926	3,316	2,923	3,442	3,450	3,482	3,235	19,848	3,223	3,201	3,136	3,334	3,237	3,091	19,222	39,070
1927	3,104	2,941	3,483	3,422	3,391	3,090	19,431	2,951	2,947	2,775	2,784	2,648	2,696	16,801	36,232
1928	2,870	2,900	3,200	3,185	3,284	3,082	18,521	3,072	3,137	3,062	3,374	3,302	3,370	19,317	37,338
1929	3,442	3,206	3,714	3,663	3,898	3,717	21,621	3,785	3,756	3,498	3,588	3,181	2,837	20,665	42,286
1930	2,827	2,839	3,246	3,182	3,233	2,934	18,261	2,639	2,524	2,277	2,165	1,867	1,666	13,139	31,399
1931	1,714	1,707	2,032	2,020	1,994	1,639	11,105	1,463	1,281	1,169	1,173	1,103	950	7,170	15,275
1932	972	964	967	852	783	628	5,168	572	520	592	644	631	546	3,518	8,886
1933	569	554	542	624	887	1,265	4,441	1,792	1,833	1,522	1,356	1,085	1,152	8,902	15,213
1934	1,215	1,264	1,620	1,727	2,043	1,930	9,798	1,225	1,054	898	951	957	1,028	6,113	15,911
1935	1,477	1,609	1,770	1,663	1,727	1,553	9,799	1,520	1,761	1,777	2,066	2,105	2,105	11,209	21,008
1936	2,026	1,824	2,040	2,404	2,648	2,556	13,528	2,594	2,712	2,730	2,992	2,947	.....	.....	.....

## Steel Castings Orders in the United States, Net Tons

(From United States Department of Commerce)

	Jan.	Feb.	March	April	May	June	Half Year	July	Aug.	Sept.	Oct.	Nov.	Dec.	Second Half	Year
1920	80,663	85,326	125,952	99,201	97,652	85,795	574,589	78,858	76,932	78,267	56,757	49,668	42,368	382,850	957,439
1921	34,401	33,906	29,260	24,512	23,311	23,739	169,129	20,177	23,327	27,822	38,105	47,286	37,200	193,917	363,046
1922	43,230	46,520	60,080	94,920	97,350	112,120	454,220	83,010	79,560	122,840	94,980	76,400	86,420	543,210	997,430
1923	126,481	112,399	172,101	118,196	117,534	109,756	756,767	73,600	76,208	71,506	64,677	63,870	61,016	410,877	1,167,644
1924	69,872	91,502	126,986	93,518	79,988	68,019	529,585	54,538	50,321	76,005	83,221	91,388	115,605	471,078	1,000,963
1925	104,179	81,930	83,812	87,556	78,417	66,437	502,331	72,294	71,160	62,198	80,510	86,957	105,893	479,012	981,343
1926	112,322	101,495	113,770	91,540	84,451	73,785	577,363	79,798	71,325	69,740	77,836	73,477	90,143	462,319	1,039,682
1927	108,063	94,938	90,353	81,403	73,043	91,199	539,001	74,569	63,938	52,742	52,160	63,075	77,436	383,920	922,921
1928	91,448	91,076	83,755	84,086	86,796	72,107	509,268	66,992	81,286	82,762	78,860	84,742	96,318	490,960	1,000,228
1929	124,313	115,639	130,836	144,366	113,092	94,873	723,119	103,046	101,514	86,241	35,879	97,635	89,985	614,300	1,337,419
1930	101,500	114,419	122,462	92,987	91,077	61,164	583,609	57,850	50,370	49,542	45,552	48,123	49,387	300,824	884,433
1931	46,810	40,320	48,184	46,039	39,052	26,136	246,541	32,869	27,458	23,073	22,854	20,001	20,799	147,064	393,595
1932	17,214	16,759	16,323	12,459	11,111	12,488	86,354	9,301	10,147	11,882	11,896	13,235	13,022	69,483	155,837
1933	14,450	13,179	13,178	15,942	22,612	34,965	114,326	31,878	31,502	25,220	26,135	25,558	25,612	165,905	280,231
1934	26,296	35,698	60,046	63,142	46,831	41,537	273,550	41,822	25,538	20,030	24,327	21,552	27,312	160,581	434,131
1935	32,349	31,725	30,723	28,233	29,083	30,257	182,370	34,570	45,426	29,995	34,553	32,714	40,529	217,787	400,157
1936	59,019	51,701	71,341	83,188	63,950	94,345	423,544	74,011	59,393	56,877	59,431	.....	.....	.....	.....

Figures for 1935-36 from 180 manufacturers, for 1933-34 from 164 manufacturers; prior to 1933, 128 producers reported.

## Malleable Castings Produced in the United States, Net Tons

(From United States Department of Commerce)

	Jan.	Feb.	March	April	May	June	Half Year	July	Aug.	Sept.	Oct.	Nov.	Dec.	Second Half	Year
1924	75,550	77,203	80,600	66,923	57,583	39,985	397,844	36,562	40,188	45,105	54,638	51,862	63,523	291,878	689,722
1925	71,188	64,825	65,889	67,608	65,714	63,343	398,587	61,727	61,042	62,798	73,195	65,248	70,622	394,632	793,199
1926	66,776	71,161	80,116	72,241	65,106	66,358	421,758	60,384	62,218	63,399	62,321	50,946	55,561	354,829	776,587
1927	56,627	62,335	72,205	64,612	62,747	64,310	382,836	53,046	57,096	50,807	52,458	46,698	53,824	313,929	696,765
1928	61,072	65,359	70,070	63,380	67,903	67,090	394,874	60,290	68,606	62,665	70,064	63,560	59,428	384,603	779,477
1929	73,125	73,875	83,365	83,744	81,641	72,232	467,982	70,600	69,173	59,087	65,526	46,459	46,029	356,874	824,856
1930	61,381	66,942	63,464	61,984	53,502	39,347	345,620	30,911	25,614	26,785	28,785	27,114	30,431	169,383	515,003
1931	31,665	34,076	35,758	36,682	31,964	24,248	194,393	20,223	18,821	18,485	20,444	17,984	21,503	117,460	311,853
1932	20,399	19,834	17,844	15,461	16,597	15,018	105,153	9,447	6,804	10,051	12,274	13,622	14,128	66,326	171,479
1933	12,638	13,780	9,959	18,566	24,628	31,118	110,689	30,865	31,511	27,078	24,381	21,944	21,870	157,949	268,838
1934	30,417	33,939	43,438	40,742	37,165	28,340	214,041	23,388	23,910	21,541	25,317	28,515	32,746	155,417	369,458
1935	43,400	41,377	42,808	42,035	34,729	27,548	231,897	28,915	35,245	36,996	43,467	44,277	45,598	234,498	466,395
1936	48,198	40,611	45,536	50,954	45,027	43,766	274,092	44,413	42,253	46,552	55,521	.....	.....	.....	.....

## Fabricated Structural Steel Orders in the United States, Net Tons

(From United States Department of Commerce Through 1932; 1933-36 Figures Computed by American Institute Steel Construction, Inc.)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1910	159,360	128,640	167,040	153,600	192,000	205,440	101,760	115,200	78,720	76,800	63,360	90,240	1,532,160
1911	114,800	94,300	135,300	114,800	129,150	159,900	141,450	166,050	153,750	106,600	180,400	178,350	1,674,850
1912	154,070	169,260	147,560	128,030	219,170	160,580	154,070	175,770	141,050	199,640	138,880	145,390	1,933,470
1913	130,500	162,000	110,250	90,000	119,250	96,750	130,500	96,750	65,250	78,750	60,750	60,750	1,201,500
1914	140,740	143,010	172,520	199,760	129,390	127,120	154,360	63,560	86,260	79,450	45,400	79,450	1,421,020
1915	57,750	69,300	147,840	143,220	140,910	184,800	198,660	196,350	154,770	180,180	242,550	279,510	1,995,840
1916	164,220	178,500	242,760	173,740	190,400	138,040	114,240	152,320	126,140	183,260	185,640	204,680	2,053,940
1917	147,620	142,780	164,560	147,620	135,520	113,740	101,640	91,960	70,180	147,620	186,340	275,880	1,725,460
1918	136,740	144,460	121,260	165,120	154,800	144,480	299,280	147,060	154,800	110,940	69,660	74,820	1,723,440
1919	31,920	34,580	47,880	66,500	130,340	172,900	196,840	207,480	207,480	207,480	183,540	226,100	1,713,040
1920	207,000	262,200	231,840	187,680	171,120	138,000	138,000	110,400	118,680	71,760	74,520	71,760	1,782,960
1921	50,940	39,620	82,070	87,730	79,240	104,710	96,220	93,390	135,840	152,820	155,650	113,200	1,191,430
1922	121,600	133,760	234,080	258,400	240,160	221,920	206,720	206,720	194,560	176,320	152,000	185,440	2,331,680
1923	227,760	243,360	290,160	243,360	177,840	165,360	162,240	184,080	165,360	159,120	171,600	249,600	2,439,840
1924	224,940	228,200	221,680	208,640	192,340	208,640	224,940	195,600	211,900	211,900	270,580	247,760	2,647,120
1925	187,380	194,320	225,550	256,780	229,020	284,540	274,130	267,190	270,660	298,420	239,430	253,310	2,980,730
1926	208,800	208,800	234,000	252,000	266,400	262,800	248,400	284,400	216,000	223,200	232,200	259,200	2,894,400
1927	195,000	240,000	232,500	262,500	232,500	225,000	341,250	270,000	262,500	288,750	236,250	262,500	3,048,750
1928	207,900	265,650	237,950	234,850	308,000	296,450	296,450	354,200	319,550	257,950	242,550	246,400	3,287,900
1929	256,025	250,635	334,565	313,775	321,475	324,170	329,175	340,725	297,990	319,550	212,335	297,605	3,587,825
1930	238,800	267,600	236,800	222,800	297,200	253,600	270,000	252,000	155,600	209,200	151,200	152,800	2,707,600
1931	158,000	158,800	178,800	284,800	152,400	172,400	159,600	124,000	194,400	109,200	90,800	97,600	1,880,800
1932	48,400	62,000	64,400	64,800	99,800	86,800	67,200	78,800	111,200	74,400	51,600	143,600	955,000
1933	93,200	63,700	87,900	56,200	52,100	101,300	67,700	95,600	72,500	63,700	65,000	103,900	922,800
1934	91,594	75,294	105,537	121,552	78,608	122,706	73,723	94,186	62,657	65,037	55,250	69,449	1,044,593
1935	64,306	75,841	102,325	95,380	60,448	120,690	65,957	102,859	90,161	102,708	91,693	96,235	1,068,603
1936	120,364	140,943	108,846	112,195	147,261	132,387	197,828	107,943	116,500	127,303	117,798	.....	.....

## Bookings of Fabricated Steel Plate in the United States, Net Tons

(From United States Department of Commerce)

	Jan.	Feb.	March	April	May	June	Half Year	July	Aug.	Sept.	Oct.	Nov.	Dec.	Second Half	Year
1923	64,832	61,797	75,065	59,850	40,081	62,736	364,361	62,510	40,990	42,945	38,598	31,846	28,806	245,695	610,056
1924	25,563	19,803	25,341	23,688	29,429	34,125	157,949	26,268	36,287	23,270	28,566	36,881	52,606	203,878	361,827
1925	30,013	24,167	26,777	27,656	32,889	38,496	179,998	34,382	40,660	31,001	34,766	32,847	35,792	209,448	389,446
1926	29,065	39,889	43,089	39,662	52,890	44,938	250,439	37,300	51,342	38,860	45,139	63,271	30,034	265,939	516,378
1927	36,043	59,843	55,675	47,611	38,063	29,936	266,171	35,609	48,780	38,863	47,296	27,524	35,877	233,949	500,120
1928	51,647	64,909	55,016	55,552	49,313	40,738	317,175	41,629	51,008	43,499	59,836	62,914	52,204	311,090	628,265
1929	40,570	70,314	69,344	54,246	58,293	57,975	350,739	58,456	51,590	51,842	45,661	52,642	27,742	287,936	638,675
1930	57,083	34,662	46,137	45,454	38,328	41,774	263,439	38,283	36,513	41,066	30,197	33,151	26,737	205,996	469,435
1931	27,518	24,438	31,056	29,916	26,210	22,806	161,944	27,261	24,282	33,473	20,839	18,268	16,442	140,565	302,509
1932	17,613	17,755	12,564	14,074	17,888	15,383	98,277	12,485	11,916	11,109	16,737	7,873	9,510	69,630	167,907
1933	11,128	16,588	8,903	9,502	16,243	37,020	99,384	20,058	16,320	16,166	17,964	14,466	13,092	98,666	198,050
1934	15,897	14,641	38,924	20,085	21,891	27,395	138,833	12,523	16,293	15,108	16,581	16,629	26,025	103,159	241,992
1935	18,778	15,064	16,832	13,244	17,630	17,914	99,462	18,590	23,628	31,105	30,530	19,116	35,584	158,853	258,316
1936	38,709	27,830	29,787	29,900	51,257	51,999	229,482	60,324	31,999	34,302	33,791	.....	.....	.....	.....

## Steel Sheets Produced by Independent Makers, Net Tons

(From National Association of Flat-Rolled Steel Manufacturers)

(Hot-Rolled Annealed, Galvanized and Full-Finished)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1923	260,520	237,919	279,475	251,808	260,006	218,432	174,910	234,112	185,577	225,714	188,144	155,299	2,671,916
1924	274,097	275,118	278,767	234,000	176,582	114,807	144,291	190,436	217,981	247,222	224,931	259,794	2,638,026
1925	317,424	283,290	290,308	280,082	260,470	266,290	246,404	270,212	295,810	348,714	336,021	326,960	3,521,985
1926	328,643	299,553	319,132	294,811	264,541	268,448	239,764	293,703	307,459	314,598	278,455	238,345	3,447,452
1927	256,856	282,171	359,340	316,100	309,360	300,706	237,243	266,645	220,919	245,765	232,041	260,130	3,285,276
1928	316,541	330,565	366,127	327,909	349,367	311,629	267,684	329,296	318,907	369,243	358,402	302,182	3,947,952
1929	391,404	326,468	364,202	375,256	393,430	337,841	323,905	366,734	302,490	319,660	204,071	181,916	3,887,377
1930	291,529	275,952	259,658	308,988	274,220	205,675	186,206	173,956	179,928	193,934	148,550	145,125	2,643,721
1931	167,865	192,218	224,323	213,608	201,846	147,843	174,890	123,752	116,842	122,739	102,758	101,570	1,890,254
1932	118,921	124,157	110,559	101,559	96,180	85,232	60,956	57,417	89,817	108,111	90,679	77,489	1,121,077
1933	85,337	91,723	64,724	111,942	139,696	166,272	188,143	203,893	180,304	146,106	102,585	113,111	1,593,836
1934	163,622	194,830	220,282	214,522	256,537	199,438	85,286	77,197	76,051	104,898	143,057	159,740	1,895,460
1935	235,714	219,062	227,082	209,219	191,507	143,309	145,505	206,613	190,701	222,963	224,541	208,774	2,424,990
1936	223,000	191,359	207,820	217,975	224,056	210,448	217,651	202,456	213,706	235,057	224,031	.....	.....

## Monthly Shipments of Steel Products by United States Steel Corp., Net Tons

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	*Total
1930	1,104,168	1,141,912	1,240,171	1,188,456	1,203,916	984,739	946,745	947,402	867,282	784,646	676,016	579,098	11,624,294
1931	800,031	762,522	907,251	878,558	764,178	653,104	593,900	573,372	486,928	476,032	435,697	351,211	7,676,744
1932	426,271	413,001	388,579	395,091	338,202	324,746	272,448	291,688	316,019	310,007	275,594	227,576	3,974,062
1933	285,138	275,929	256,793	335,321	455,302	603,937	701,322	685,155	575,161	572,897	490,358	600,639	5,805,235
1934	331,777	355,500	588,209	643,009	745,063	985,337	369,933	378,023	370,306	343,962	366,119	418,630	5,925,873
1935	534,055	553,137	668,056	591,728	598,915	579,108	547,794	624,497	614,333	686,741	681,220	661,515	7,371,299
1936	721,414	676,315	783,552	979,907	984,097	886,065	950,551	923,703	961,803	1,007,417	882,643	.....	.....

\*Less yearly adjustment.

# Monthly Average Pig Iron Prices Computed From Composite Pig

Average of THE IRON AGE quotations on basic pig iron at  
Buffalo, Valley and Philadel

	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Jan.....	\$13.50	\$15.82	\$22.06	\$13.47	\$15.95	\$17.30	\$23.24	\$16.84	\$15.68	\$17.12	\$13.63	\$12.65	\$16.49	\$12.76	\$12.38	\$17.81	\$28.88	\$33.21
Feb.....	13.97	16.14	21.47	13.17	15.84	17.10	23.33	16.30	15.35	16.77	13.83	12.61	16.31	13.18	12.38	17.76	29.75	33.21
March.....	15.12	16.93	21.54	13.43	15.98	17.10	23.02	15.97	15.03	16.29	13.88	12.93	16.07	13.16	12.34	18.06	32.18	33.21
April.....	15.53	18.27	20.93	13.65	15.68	17.03	23.03	15.55	14.38	15.97	13.79	13.09	15.74	13.13	12.37	18.15	38.56	32.71
May.....	15.21	19.96	19.54	13.19	15.63	17.07	23.97	15.16	14.38	15.27	13.53	13.27	14.98	13.06	12.37	18.08	41.87	32.71
June.....	14.84	20.91	18.83	12.66	15.04	16.94	23.47	15.35	14.71	14.90	13.27	13.36	14.35	12.97	12.45	17.91	47.95	32.71
July.....	14.79	21.25	17.79	11.84	14.37	16.96	22.51	14.91	15.18	14.72	13.21	13.68	13.99	12.92	12.55	17.79	52.11	32.73
Aug.....	14.68	21.70	16.98	12.07	14.64	17.68	21.82	15.05	15.52	14.39	13.12	14.15	13.93	12.91	13.55	17.63	51.43	32.73
Sept.....	14.63	22.27	16.03	12.07	14.94	18.59	20.55	15.03	16.41	14.17	12.99	14.74	13.97	12.83	14.28	17.82	46.93	32.73
Oct.....	14.84	22.35	15.02	12.67	15.61	19.52	19.88	14.79	17.25	13.79	12.84	16.01	13.93	12.67	14.67	19.18	33.21	34.31
Nov.....	14.98	22.54	14.23	14.37	17.01	22.17	18.66	15.21	17.46	13.74	12.71	16.52	13.39	12.42	15.82	24.36	33.21	34.36
Dec.....	15.34	22.33	13.75	15.77	17.10	22.82	17.52	15.73	17.26	13.78	12.59	16.63	13.06	12.39	17.34	28.63	33.21	34.26
Aver.....	14.79	20.04	18.18	13.80	15.65	18.56	21.75	15.49	15.72	15.08	13.88	14.14	14.68	12.87	13.54	19.43	39.11	35.24

## Basic Pig Iron at Mahoning or Shenango Valley Furnace, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$37.40	\$30.00	\$18.15	\$25.80	\$21.25	\$22.00	\$20.00	\$18.00	\$17.00	\$17.50	\$18.50	\$17.00	\$15.00	\$13.50	\$17.00	\$18.00	\$19.00
Feb.....	42.25	27.50	17.75	26.25	22.00	22.00	20.00	18.00	17.00	17.50	18.50	16.75	14.62	13.50	17.00	18.00	19.00
March.....	41.50	24.20	17.94	30.13	21.94	21.30	20.00	18.40	17.00	17.50	18.50	16.50	14.50	13.50	17.00	18.00	19.00
April.....	42.40	22.88	20.00	31.05	21.55	20.13	18.63	19.00	16.88	17.90	18.50	16.50	14.50	13.50	17.25	18.00	19.00
May.....	43.25	22.00	24.60	29.00	20.50	18.81	18.38	18.20	16.30	18.38	18.50	16.25	14.20	14.20	18.00	18.00	19.00
June.....	44.00	20.75	25.00	27.38	19.63	18.05	18.00	17.88	15.45	18.50	18.50	15.50	14.00	15.00	18.00	18.00	19.00
July.....	45.85	19.38	24.25	25.10	19.00	18.00	17.63	17.50	16.00	18.50	18.10	15.50	13.50	15.50	18.00	18.00	19.00
Aug.....	48.10	18.20	26.60	24.75	19.00	18.00	17.50	17.30	16.00	18.50	18.00	15.50	13.50	16.20	18.00	18.00	19.00
Sept.....	49.50	19.13	32.63	24.88	19.00	18.30	17.50	17.06	16.19	18.50	17.60	15.50	13.50	17.00	18.00	18.00	19.00
Oct.....	43.75	19.19	30.90	23.50	19.00	18.63	18.00	17.00	17.10	18.50	17.00	15.25	13.50	17.00	18.00	18.00	19.00
Nov.....	36.50	19.00	27.75	20.88	19.13	19.88	18.50	17.00	17.50	18.50	17.00	15.00	13.50	17.00	18.00	19.00	19.25
Dec.....	33.00	18.63	24.81	21.00	20.90	20.00	18.50	17.00	17.50	18.50	17.00	15.00	13.50	17.00	18.00	19.00	20.00
Aver.....	42.21	21.74	24.20	25.81	20.24	19.59	18.65	17.70	16.66	18.19	17.98	15.85	13.98	15.24	17.69	18.17	19.10

## No. 2 Foundry Iron at Mahoning or Shenango Valley Furnace, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$39.40	\$31.88	\$19.30	\$27.00	\$22.50	\$22.38	\$20.50	\$18.50	\$17.25	\$17.50	\$18.50	\$17.00	\$15.50	\$14.50	\$17.50	\$18.50	\$19.50
Feb.....	41.50	28.00	18.88	27.50	23.00	22.00	20.50	18.50	17.25	17.50	18.50	16.75	15.12	14.50	17.50	18.50	19.50
March.....	41.25	25.90	19.00	30.50	23.00	21.10	20.50	18.50	17.25	17.75	18.50	16.50	15.00	14.50	17.50	18.50	19.50
April.....	42.80	24.75	20.75	31.00	21.80	20.13	19.00	18.50	17.25	18.00	18.50	17.00	15.00	14.50	17.75	18.50	19.50
May.....	44.25	23.50	23.80	30.20	20.75	19.13	18.88	18.50	17.20	18.50	18.50	17.00	14.70	14.70	18.50	18.50	19.50
June.....	45.00	22.10	24.00	27.63	19.63	18.30	17.96	18.13	16.75	18.50	18.50	17.00	14.50	15.50	18.50	18.50	19.50
July.....	45.00	20.13	24.25	25.50	19.00	18.50	17.69	18.00	16.65	18.50	18.10	17.00	14.50	16.00	18.50	18.50	19.50
Aug.....	47.00	19.63	32.60	24.88	19.13	18.50	17.50	17.60	16.50	18.50	18.00	17.00	14.50	16.70	18.50	18.50	19.50
Sept.....	49.40	21.00	34.88	24.75	19.80	18.80	17.63	17.50	16.88	18.50	17.80	17.00	14.50	17.60	18.50	18.50	19.50
Oct.....	46.50	21.00	31.80	23.60	19.50	19.13	18.50	17.50	17.10	18.50	17.13	16.63	14.50	17.50	18.50	18.50	19.50
Nov.....	40.25	20.75	27.88	21.88	19.50	20.39	19.00	17.45	17.63	18.50	17.00	16.00	14.50	17.50	18.50	19.50	19.75
Dec.....	36.20	20.00	25.63	22.00	21.20	20.50	18.80	17.25	17.70	18.50	17.00	15.70	14.50	17.50	18.50	19.50	20.50
Aver.....	43.21	23.22	25.23	26.37	20.75	19.90	18.87	18.00	17.12	18.23	18.00	16.72	14.73	15.91	18.19	18.67	19.60

## Malleable Pig Iron at Mahoning or Shenango Valley Furnace, Gross Ton

	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$19.50	\$27.00	\$22.39	\$22.39	\$20.50	\$18.50	\$17.30	\$18.00	\$19.00	\$17.50	\$16.00	\$14.50	\$17.50	\$18.50	\$19.50
Feb.....	19.00	27.63	23.00	22.00	20.50	18.50	17.25	18.00	19.00	17.25	15.62	14.50	17.50	18.50	19.50
March.....	19.00	30.50	22.50	21.50	20.50	18.50	17.25	18.25	19.00	17.00	15.50	14.50	17.50	18.50	19.50
April.....	19.50	31.00	22.10	20.63	19.00	18.50	17.25	18.50	19.00	17.00	15.50	14.50	17.75	18.50	19.50
May.....	24.20	30.20	21.00	19.25	18.88	18.50	17.25	19.00	19.00	17.00	15.20	14.70	18.50	18.50	19.50
June.....	24.50	28.13	19.88	18.50	18.05	18.13	17.00	19.00	19.00	17.00	15.00	15.50	18.50	18.50	19.50
July.....	25.13	25.40	19.00	18.50	17.75	18.00	17.00	19.00	18.60	17.00	14.50	16.00	18.50	18.50	19.50
Aug.....	29.50	24.50	19.13	18.50	17.50	17.60	17.00	19.00	18.50	17.00	14.50	16.70	18.50	18.50	19.50
Sept.....	33.50	24.50	19.80	18.80	17.63	17.50	17.19	19.00	18.30	17.00	14.50	17.50	18.50	18.50	19.50
Oct.....	32.70	23.30	19.50	19.13	18.50	17.50	17.65	19.00	17.75	16.88	14.50	17.50	18.50	18.50	19.50
Nov.....	29.00	20.88	19.75	20.38	19.00	17.50	18.19	19.00	17.50	16.50	14.50	17.50	18.50	19.50	19.75
Dec.....	26.25	20.00	21.20	20.50	18.75	17.50	18.15	19.00	17.50	16.20	14.50	17.50	18.50	19.50	20.50
Aver.....	25.15	26.09	20.77	20.01	18.88	18.02	17.37	18.73	18.51	16.94	14.98	15.91	18.19	18.67	19.60

## No. 2 Foundry Pig Iron at St. Louis and at Granite City,\* Ill., Furnace, Gross Ton

	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$25.68	\$25.06	\$24.56	\$22.31	\$20.56	\$20.75	\$20.50	\$18.25	\$18.33	\$18.33	\$17.50	\$18.50	\$19.50
Feb.....	26.56	26.06	24.56	22.06	20.56	20.75	20.50	18.25	18.33	18.33	17.50	18.50	19.50
March.....	26.56	26.06	24.56	21.86	20.56	20.75	20.44	18.25	18.33	18.33	17.50	18.50	19.50
April.....	26.56	24.37	24.00	21.56	20.56	20.75	20.25	18.25	18.33	17.34	17.75	18.50	19.50
May.....	24.31	22.50	23.56	21.56	19.81	20.75	19.75	18.25	18.33	16.55	18.50	18.50	19.50
June.....	23.68	21.56	23.16	21.31	19.81	20.75	19.75	18.25	18.33	16.85	18.50	18.50	19.50
July.....	22.01	21.56	23.06	21.06	19.76	20.75	19.10	18.25	18.33	17.35	18.50	18.50	19.50
Aug.....	22.12	21.81	23.06	20.56	19.68	20.69	19.00	18.25	18.33	17.85	18.50	18.50	19.50
Sept.....	22.46	22.96	23.06	20.56	20.31	20.50	18.70	18.25	18.33	*17.50	18.50	18.50	19.50
Oct.....	22.56	23.62	22.56	20.56	20.56	20.50	18.25	18.25	18.33	17.50	18.50	18.70	19.50
Nov.....	22.56	24.12	22.36	20.56	20.87	20.50	18.25	18.25	18.33	17.50	18.50	19.50	19.75
Dec.....	24.26	24.56	22.56	20.56	20.81	20.50	18.25	18.25	18.33	17.50	18.50	19.50	20.60
Aver.....	\$1.11	\$3.69	\$3.42	\$1.21	\$0.33	\$0.66	19.39	18.85	18.33	17.68	18.19	18.68	19.60

# Weekly Market Quotations In THE IRON AGE

## Iron Price

Valley furnace and foundry iron at Chicago, Birmingham, phia. Quoted in gross tons

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$31.36	\$39.39	\$31.18	\$18.48	\$26.78	\$22.15	\$22.44	\$21.79	\$19.44	\$17.63	\$18.43	\$18.19	\$15.90	\$14.68	\$13.56	\$16.90	\$17.90	\$18.84
Feb.....	31.36	42.35	28.45	18.14	27.20	22.84	22.50	21.77	19.07	17.73	18.38	18.02	15.80	14.51	13.56	16.90	17.90	18.84
March.....	30.10	42.24	25.18	18.35	30.11	22.81	21.99	21.65	19.03	17.73	18.36	17.75	15.71	14.45	13.56	16.90	17.90	18.84
April.....	27.11	43.01	23.73	20.00	30.83	22.31	20.95	20.96	19.21	17.67	18.52	17.73	15.79	14.35	13.76	17.07	17.90	18.84
May.....	26.91	43.64	22.78	23.35	29.74	21.40	19.85	20.69	19.09	17.45	18.70	17.60	15.76	14.12	14.48	17.90	17.84	18.84
June.....	26.46	44.09	21.73	23.95	28.23	20.27	19.22	20.00	18.92	17.23	18.65	17.48	15.62	14.01	15.01	17.90	17.84	18.84
July.....	26.37	45.44	20.22	23.86	25.96	19.31	18.96	19.51	18.56	17.10	18.48	17.16	15.56	13.76	15.50	17.90	17.84	18.84
Aug.....	26.83	47.38	18.97	26.69	25.19	19.40	19.01	19.46	18.17	17.11	18.39	16.90	15.51	13.69	16.09	17.90	17.84	18.73
Sept.....	27.11	47.83	19.89	31.78	25.02	19.46	19.39	19.46	18.03	17.54	18.27	16.70	15.44	13.64	16.71	17.90	17.84	18.73
Oct.....	27.52	45.05	19.97	30.57	23.30	19.46	19.92	19.69	17.96	17.94	18.33	16.31	15.21	13.63	16.61	17.90	17.87	18.73
Nov.....	30.34	38.65	19.79	27.82	21.40	19.79	21.16	20.13	17.59	18.46	18.36	16.21	14.97	13.59	16.61	17.90	18.84	18.98
Dec.....	36.13	34.51	19.11	25.70	21.88	21.60	21.54	19.94	17.55	18.51	18.24	15.95	14.86	13.56	16.90	17.90	18.84	19.73
Aver.....	28.97	42.70	22.58	24.06	26.80	20.90	20.53	20.42	18.55	17.68	18.43	17.17	15.51	14.00	15.80	17.58	18.03	18.90

## Eastern Pennsylvania No. 2X Foundry Pig Iron at Philadelphia, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$44.10	\$33.34	\$21.34	\$29.76	\$24.11	\$25.01	\$24.26	\$22.76	\$20.56	\$21.76	\$21.26	\$18.26	\$16.14	\$13.84	\$19.51	\$20.51	\$21.56
Feb.....	45.10	31.09	21.09	30.01	24.04	25.01	24.14	22.26	21.14	21.76	21.26	18.26	16.14	13.34	19.51	20.51	21.56
March.....	45.53	27.69	21.26	32.30	24.16	24.21	23.36	22.26	21.26	21.89	20.76	18.26	16.12	13.84	19.51	20.51	21.56
April.....	46.85	26.26	23.62	32.95	23.06	22.82	23.26	22.26	21.26	22.26	20.76	18.26	16.09	14.59	19.76	20.51	21.56
May.....	47.10	25.71	26.09	32.76	22.67	21.51	22.89	22.26	21.26	22.26	20.39	17.76	15.34	15.99	20.51	20.55	21.56
June.....	47.15	25.50	27.06	30.76	21.85	21.26	22.66	22.14	21.26	22.26	20.26	17.71	15.34	16.84	20.51	20.56	21.56
July.....	48.15	23.55	27.92	27.68	21.26	21.26	22.26	21.51	20.86	22.16	19.96	17.51	14.84	17.22	20.51	20.56	21.56
Aug.....	51.96	20.64	32.26	25.89	21.51	21.57	22.26	21.26	20.76	21.76	19.76	17.32	14.54	17.79	20.51	20.56	21.56
Sept.....	53.51	21.22	34.83	26.26	21.76	21.96	22.26	20.76	21.01	21.76	19.56	16.86	14.34	18.59	20.51	20.56	21.56
Oct.....	52.53	22.23	32.54	24.04	21.76	22.64	22.26	20.51	21.26	21.76	19.26	16.64	14.28	18.51	20.51	20.56	21.56
Nov.....	44.99	22.74	30.39	23.01	22.64	23.64	23.56	20.26	21.64	21.76	19.01	16.07	14.09	18.51	20.51	21.56	21.81
Dec.....	35.54	21.82	28.86	24.26	24.56	24.26	23.39	20.26	21.76	21.46	18.26	16.01	13.84	19.51	20.51	21.56	22.56
Aver.....	46.88	26.14	27.27	28.31	22.78	22.93	23.05	21.55	21.17	21.90	20.04	17.41	15.09	16.55	20.20	20.71	21.68

## Basic Pig Iron, Delivered Eastern Pennsylvania, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$39.19	\$33.51	\$20.18	\$27.80	\$23.00	\$24.25	\$23.00	\$21.50	\$19.50	\$19.75	\$19.50	\$17.25	\$16.25	\$13.50	\$18.76	\$19.76	\$20.81
Feb.....	41.90	30.65	19.84	28.19	22.69	23.88	23.00	21.19	19.50	19.88	19.44	17.25	16.25	13.50	18.76	19.76	20.81
March.....	44.24	26.15	22.61	29.56	21.81	23.55	22.10	20.85	19.50	20.25	19.06	17.25	16.00	13.50	18.76	19.76	20.81
April.....	44.80	25.00	21.00	30.81	21.50	22.31	21.75	20.75	19.50	20.25	18.90	17.13	16.00	14.09	18.91	19.76	20.81
May.....	44.80	25.00	24.00	30.60	21.00	21.13	21.75	20.75	19.10	20.25	18.75	17.00	16.00	15.29	19.76	19.79	20.81
June.....	44.66	24.63	25.00	28.14	21.00	21.50	21.45	20.75	19.00	20.25	18.75	17.00	16.00	16.09	19.76	19.81	20.81
July.....	43.70	22.38	25.75	26.60	20.20	21.50	21.00	20.75	18.95	20.20	18.45	16.75	15.50	16.59	19.76	19.81	20.81
Aug.....	47.21	19.70	27.23	25.00	20.00	20.50	20.95	20.15	18.75	19.75	18.25	16.75	14.20	17.24	19.76	19.81	20.81
Sept.....	51.26	19.19	30.83	25.00	20.00	20.70	20.75	20.00	18.88	19.75	18.15	16.75	13.50	17.84	19.76	19.81	20.81
Oct.....	49.60	20.50	29.30	24.20	20.00	21.25	20.69	20.00	19.45	19.75	17.75	16.75	13.50	17.76	19.76	19.81	20.81
Nov.....	41.94	20.70	27.83	22.88	21.13	22.39	22.60	19.60	19.75	19.75	17.75	16.39	13.50	17.76	19.76	20.81	21.06
Dec.....	44.15	20.63	27.31	23.13	23.41	23.00	22.00	19.25	20.05	19.55	17.75	16.25	13.50	18.76	19.76	20.81	21.81
Aver.....	44.79	24.00	25.08	26.83	21.31	22.16	21.75	20.46	19.33	19.95	18.54	16.87	15.08	16.99	19.45	19.98	20.91

## No. 2 Foundry Pig Iron at Cleveland Furnace, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$40.00	\$33.40	\$20.06	\$27.37	\$23.20	\$23.37	\$21.82	\$19.00	\$18.00	\$19.00	\$19.00	\$17.50	\$16.00	\$15.00	\$17.50	\$18.50	\$19.50
Feb.....	41.90	30.22	20.06	28.50	24.00	23.49	21.88	18.63	18.00	19.00	19.00	17.50	16.00	15.00	17.50	18.50	19.50
March.....	43.15	27.80	21.55	31.65	24.00	23.97	21.31	19.40	18.00	19.00	19.00	17.20	15.70	15.00	17.50	18.50	19.50
April.....	43.40	26.62	20.81	32.02	23.75	22.32	20.35	19.37	18.00	19.00	18.88	17.00	15.50	15.00	18.00	18.50	19.50
May.....	44.53	25.50	23.75	31.71	22.75	20.37	19.50	19.00	18.00	19.00	18.50	17.00	15.50	15.30	18.50	18.50	19.50
June.....	44.90	24.00	24.06	29.96	21.00	19.62	19.19	18.70	17.88	19.00	18.50	17.00	15.50	15.50	18.50	18.50	19.50
July.....	45.20	21.31	24.75	26.94	19.75	19.50	19.00	18.50	17.50	19.00	18.00	17.00	15.50	16.00	18.50	18.50	19.50
Aug.....	48.06	20.50	31.31	25.90	20.06	19.50	19.00	18.50	17.60	19.00	18.00	17.00	15.50	16.70	18.50	18.50	19.50
Sept.....	49.86	20.75	35.94	25.37	20.31	19.50	19.00	18.50	17.88	19.00	17.60	17.00	15.00	17.50	18.50	18.50	19.50
Oct.....	47.88	20.75	33.59	24.75	20.50	20.05	19.37	18.38	18.13	19.00	17.50	17.00	15.00	17.50	18.50	18.50	19.50
Nov.....	43.46	20.56	29.97	22.85	20.81	21.82	20.10	18.00	19.00	19.00	17.50	17.00	15.00	17.50	18.50	19.50	19.75
Dec.....	36.32	19.95	26.85	22.56	21.88	21.76	19.88	18.00	19.00	19.00	17.50	16.60	15.00	17.50	18.50	19.50	20.50
Aver.....	44.06	24.28	26.05	27.47	21.84	21.19	20.03	18.67	18.16	19.00	18.25	17.07	15.43	16.13	18.31	18.67	19.60

## No. 2 Foundry Pig Iron at Buffalo Furnace, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$40.00	\$32.38	\$19.44	\$26.94	\$22.25	\$23.00	\$21.00	\$18.50	\$17.00	\$18.00	\$18.75	\$17.50	\$16.00	\$16.00	\$17.50	\$18.50	\$19.50
Feb.....	42.00	30.50	18.87	27.56	22.25	22.75	21.00	17.39	17.00	18.39	18.50	17.50	16.00	16.00	17.50	18.50	19.50
March.....	44.75	29.00	18.30	29.05	21.81	22.12	21.00	17.05	17.00	18.50	18.50	17.50	16.00	16.00	17.50	18.50	19.50
April.....	45.00	26.15	20.81	29.56	21.37	20.65	21.00	17.50	17.00	18.50	18.50	17.50	16.00	16.00	17.50	18.50	19.50
May.....	45.00	25.62	22.62	29.40	20.25	19.00	20.75	17.50	17.00	18.50	18.50	17.13	16.00	16.00	18.50	18.50	19.50
June.....	44.75	23.42	23.05	29.06	19.37	19.00	19.60	17.39	17.00	18.75	18.50	17.00	16.00	16.00	18.50	18.50	19.50
July.....	45.00	20.87	24.50	26.00	19.00	18.85	19.00	16.94	17.00	19.50	18.50	17.00	16.00	16.50	18.50	18.50	19.50
Aug.....	47.75	19.50	30.70	24.95	19.19	18.72	19.00	16.20	17.00	19.50	18.50	17.00	16.00	17.10	18.50	18.50	19.50
Sept.....	50.10	20.00	33.94	24.87	19.37	18.75	19.00	16.25	17.00	19.50	18.50	17.00	16.00	17.50	18.50	18.50	19.50
Oct.....	47.44	20.37	31.12	23.06	19.05	19.40	19.00	16.88	17.10	19.50	17.75	17.00	16.00	17.50	18.50	18.50	19.50
Nov.....	42.56	19.12	27.80	20.87	20.50	21.19	19.00	17.00	17.88	19.50	17.50	17.00	16.00	17.50	18.50	19.50	19.75
Dec.....	36.60	19.30	25.50	21.56	22.62	21.50	19.00	17.00	18.00	19.50	17.50	16.80	16.00	17.50	18.50	19.50	20.50
Aver.....	44.32	19.85	24.72	26.07	20.69	20.41	19.86	17.13	17.17	18.97	18.29	17.16	16.00	16.63	18.17	18.67	19.60

### No. 2 Foundry Pig Iron at Chicago Furnace, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$40.00	\$31.50	\$18.90	\$28.90	\$23.70	\$24.00	\$23.00	\$20.88	\$18.50	\$20.00	\$20.00	\$17.50	\$16.50	\$15.50	\$17.50	\$18.50	\$19.50
Feb.....	42.25	29.00	19.00	29.75	24.50	24.00	23.00	20.25	18.50	20.00	20.00	17.50	16.50	15.50	17.50	18.50	19.50
March.....	43.00	25.60	20.00	31.25	24.38	23.80	23.00	20.00	18.50	20.00	19.50	17.50	16.50	15.50	17.50	18.50	19.50
April.....	43.00	24.00	20.50	32.00	24.10	22.50	22.00	20.00	18.50	20.00	19.40	17.50	16.00	15.50	17.75	18.50	19.50
May.....	43.00	22.80	22.60	32.00	22.75	21.13	21.63	20.00	18.20	20.00	19.00	17.50	16.00	15.80	18.50	18.50	19.50
June.....	43.40	20.75	23.25	31.25	21.25	20.30	21.10	20.00	18.00	20.00	18.39	17.50	16.00	16.00	18.50	18.50	19.50
July.....	45.25	19.00	24.25	27.90	19.60	20.50	21.00	20.00	17.60	20.00	17.90	17.50	15.50	16.78	18.50	18.50	19.50
Aug.....	46.00	19.55	28.60	27.00	20.38	20.50	21.00	19.50	17.63	20.00	17.50	17.50	15.50	17.10	18.50	18.50	19.50
Sept.....	46.00	21.75	32.00	26.75	20.50	21.00	21.00	19.50	18.25	20.00	17.50	17.50	15.50	17.50	18.50	18.50	19.50
Oct.....	44.50	21.00	31.40	25.00	20.50	21.63	21.00	19.00	18.50	20.00	17.50	17.00	15.50	17.50	18.50	18.70	19.50
Nov.....	39.40	20.60	29.75	23.13	21.00	22.75	21.00	18.50	20.00	20.00	17.50	17.00	15.50	17.50	18.50	19.50	19.75
Dec.....	34.50	19.63	28.00	23.00	22.50	23.00	21.00	18.50	20.00	20.00	17.50	16.70	15.50	17.50	18.50	19.50	20.50
Aver.....	42.53	22.93	24.85	28.16	22.10	22.09	21.64	19.68	18.54	20.00	18.47	17.35	15.87	16.47	18.19	18.68	19.60

### Malleable Pig Iron at Chicago Furnace, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$40.50	\$32.00	\$18.90	\$28.90	\$23.88	\$24.00	\$23.00	\$20.88	\$18.50	\$20.00	\$20.00	\$17.50	\$16.50	\$15.50	\$17.50	\$18.50	\$19.50
Feb.....	42.75	29.38	19.13	29.75	24.50	24.00	23.00	20.25	18.50	20.00	20.00	17.50	16.50	15.50	17.50	18.50	19.50
March.....	43.50	25.80	20.00	31.25	24.38	24.00	23.00	20.00	18.50	20.00	19.50	17.50	16.50	15.50	17.50	18.50	19.50
April.....	43.50	24.00	20.50	32.00	24.10	22.63	22.00	20.00	18.50	20.00	19.40	17.50	16.00	15.50	17.75	18.50	19.50
May.....	43.50	23.00	22.60	32.00	22.75	21.25	21.42	20.00	18.22	20.00	19.00	17.50	16.00	15.80	18.50	18.50	19.50
June.....	43.50	21.50	23.25	31.25	21.25	20.60	21.10	20.00	18.00	20.00	18.50	17.50	16.00	16.00	18.50	18.50	19.50
July.....	45.25	19.00	24.25	27.90	19.60	20.50	21.00	20.00	17.60	20.00	17.90	17.50	15.50	16.78	18.50	18.50	19.50
Aug.....	46.50	19.60	28.60	27.00	20.38	20.50	21.00	19.50	17.63	20.00	17.50	17.50	15.50	17.10	18.50	18.50	19.50
Sept.....	46.50	21.75	32.00	26.75	20.50	21.00	21.00	19.50	18.25	20.00	17.50	17.50	15.50	17.50	18.50	18.50	19.50
Oct.....	45.75	21.00	31.40	25.00	20.50	21.63	21.00	19.00	18.50	20.00	17.50	17.10	15.50	17.50	18.50	18.70	19.50
Nov.....	39.90	20.60	29.75	23.13	20.88	22.75	21.00	18.50	20.00	20.00	17.50	17.00	15.50	17.50	18.50	19.50	19.75
Dec.....	35.00	19.63	28.00	23.00	22.62	23.00	21.00	18.50	20.00	20.00	17.50	16.70	15.50	17.50	18.50	19.50	20.50
Aver.....	43.01	23.11	24.87	28.16	22.11	22.15	21.63	19.68	18.54	20.00	18.48	17.36	15.87	16.47	18.19	18.68	19.60

### Lake Superior Charcoal Pig Iron at Chicago, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$48.75	\$42.50	\$31.10	\$33.15	\$29.15	\$29.04	\$29.04	\$27.04	\$27.04	\$27.04	\$27.04	\$27.04	\$23.17	\$23.17	\$23.54	\$24.04	\$25.25
Feb.....	58.38	39.60	29.38	33.90	29.15	29.04	29.04	27.04	27.04	27.04	27.04	27.04	23.17	23.17	23.54	24.04	25.25
March.....	58.20	38.50	26.00	35.40	29.15	29.04	29.04	27.04	27.04	27.04	25.04	26.24	23.17	23.17	23.54	24.04	25.25
April.....	57.25	38.50	26.50	36.53	29.15	29.04	29.04	27.04	27.04	27.04	27.04	25.04	23.17	23.17	24.79	24.13	25.25
May.....	57.50	37.50	28.40	36.65	29.15	29.04	29.04	27.04	27.04	27.04	27.04	25.04	23.17	23.17	24.04	24.25	25.25
June.....	57.50	37.50	29.75	36.65	29.12	29.04	29.04	27.04	27.04	27.04	27.04	25.04	23.17	23.17	24.04	24.25	25.25
July.....	57.50	36.37	31.65	34.81	29.04	29.04	29.04	27.04	27.04	27.04	27.04	25.04	23.17	23.17	24.04	24.25	25.25
Aug.....	57.70	33.60	34.05	32.04	29.04	29.04	29.04	27.04	27.04	27.04	27.04	25.04	23.17	23.17	24.04	24.25	25.25
Sept.....	58.50	33.00	36.15	32.04	29.04	29.04	29.04	27.04	27.04	27.04	27.04	25.04	23.17	23.67	24.04	24.25	25.25
Oct.....	58.50	31.60	36.15	29.86	29.04	29.04	27.54	27.04	27.04	27.04	27.04	25.04	23.17	23.54	24.04	24.85	25.25
Nov.....	55.75	31.50	36.15	28.40	29.04	29.04	27.54	27.04	27.04	27.04	27.04	25.04	23.17	23.54	24.04	25.25	25.50
Dec.....	49.13	31.50	34.65	29.15	29.04	29.04	27.04	27.04	27.04	27.04	27.04	23.04	23.17	23.54	24.04	25.25	25.25
Aver.....	56.22	35.96	31.66	33.22	29.09	29.04	28.58	27.04	27.04	27.04	26.87	25.31	23.17	23.30	23.98	24.35	25.35

### Southern No. 2 Foundry Pig Iron at Birmingham, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$38.75	\$32.25	\$16.20	\$23.25	\$21.50	\$20.00	\$22.00	\$18.50	\$16.00	\$16.50	\$14.50	\$13.80	\$11.50	\$11.00	\$13.50	\$14.50	\$15.50
Feb.....	40.00	28.13	15.00	24.38	22.50	20.00	22.00	18.00	16.00	16.50	14.63	12.88	11.00	11.00	13.50	14.50	15.50
March.....	40.00	25.30	15.00	26.40	22.50	20.00	22.00	18.00	16.00	16.00	14.50	12.38	11.00	11.00	13.50	14.50	15.50
April.....	40.50	23.50	15.88	27.00	22.30	20.00	22.00	18.00	16.00	15.40	14.00	12.00	11.00	11.25	13.50	14.50	15.50
May.....	42.00	22.20	17.60	26.85	21.50	20.00	22.00	18.00	15.70	15.00	14.00	12.00	11.00	12.00	14.30	14.50	15.50
June.....	42.00	21.88	18.38	25.75	20.00	19.60	21.20	18.00	15.88	15.00	14.00	12.00	11.00	12.00	14.50	14.50	15.50
July.....	42.00	20.25	18.25	25.00	18.00	18.00	21.00	17.44	15.50	14.63	14.00	12.00	11.00	12.50	14.50	14.50	15.50
Aug.....	42.00	19.00	20.10	23.70	17.50	18.00	21.00	17.25	15.69	14.50	14.00	12.00	11.00	13.10	14.50	14.50	*15.88
Sept.....	42.00	19.00	26.00	22.75	17.50	18.50	20.75	17.25	16.25	14.50	14.00	12.00	11.00	13.50	14.50	14.50	15.88
Oct.....	42.00	19.00	26.80	20.63	17.50	19.38	20.00	17.25	16.25	14.50	14.00	12.00	11.00	13.50	14.50	14.50	15.88
Nov.....	38.00	18.40	23.50	19.60	17.75	21.00	20.00	16.39	16.39	14.50	14.00	12.00	11.00	13.50	14.50	14.75	16.13
Dec.....	38.00	17.33	22.88	21.00	19.80	22.00	20.00	16.00	16.50	14.50	14.00	12.00	11.00	13.50	14.50	15.50	16.88
Aver.....	40.60	22.19	19.63	23.86	19.86	19.71	21.16	17.47	16.01	15.13	14.14	12.27	11.04	12.32	14.15	14.60	15.76

\*Commencing August, 1936, 38c. a ton deducted for 0.70 phosphorous and over.

### Southern No. 2 Foundry Pig Iron at Cincinnati, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$41.80	\$36.75	\$20.70	\$27.45	\$25.55	\$24.05	\$25.69	\$22.19	\$19.69	\$20.19	\$17.69	\$14.19	\$14.07	\$13.82	\$18.13	\$19.13	\$20.20
Feb.....	43.60	32.63	20.00	28.68	26.55	24.05	25.69	21.69	19.69	20.19	17.19	14.19	13.82	13.82	18.13	19.13	20.20
March.....	43.60	29.80	19.50	30.80	26.55	24.05	25.69	21.69	19.69	19.69	16.69	14.19	13.82	13.82	18.13	19.13	20.20
April.....	44.00	28.00	20.38	31.05	26.35	24.05	25.69	21.69	19.69	19.09	16.69	14.19	13.82	14.32	18.13	19.13	20.20
May.....	45.60	26.70	22.10	30.75	25.55	24.05	25.69	21.69	19.39	18.69	16.69	14.69	13.82	15.96	19.13	19.13	20.20
June.....	45.60	26.38	23.00	29.30	24.05	23.25	24.59	21.69	19.56	18.69	16.69	14.69	13.82	16.51	19.13	19.20	20.20
July.....	45.60	24.75	22.30	28.85	22.05	22.18	24.19	21.13	19.19	17.99	16.39	14.69	13.82	17.01	19.13	19.20	20.20
Aug.....	45.78	23.50	24.35	27.68	21.55	22.55	24.19	20.94	19.39	17.57	15.82	14.69	13.82	17.83	19.13	19.20	19.44
Sept.....	46.50	23.50	29.65	26.55	21.55	22.85	24.07	20.94	19.94	17.19	15.49	14.69	13.82	18.23	19.12	19.20	19.44
Oct.....	46.50	23.50	30.85	24.68	21.55	23.43	23.69	20.94	19.94	17.30	15.19	14.69	13.82	18.13	19.13	19.20	19.44
Nov.....	42.50	22.90	27.55	23.65	21.80	24.87	23.69	19.69	20.07	17.69	14.94	14.69	13.82	18.13	19.13	20.20	19.69
Dec.....	42.50	21.75	26.93	25.05	23.85	25.49	23.69	19.69	20.19	17.69	14.39	14.69	13.82	18.13	19.13	20.20	20.44
Aver.....	44.47	36.68	28.93	27.87	25.91	23.74	24.71	21.16	19.70	18.61	16.16	14.58	13.84	16.51	18.80	19.84	19.99

## Ferroalloy Quotations

### Ferromanganese (80 Per Cent), Gross Ton, at Seaboard

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$146.00	\$112.50	\$58.35	\$105.00	\$108.70	\$112.50	\$115.00	\$100.00	\$100.00	\$105.00	\$100.00	\$80.00	\$75.00	\$68.00	\$85.00	\$85.00	\$75.00
Feb.....	172.50	100.00	60.42	107.50	107.50	115.00	115.00	100.00	100.00	105.00	95.50	80.00	75.00	68.00	85.00	85.00	75.00
March.....	216.25	96.00	62.50	113.75	107.50	115.00	97.60	100.00	100.00	105.00	94.00	80.00	75.00	68.00	85.00	85.00	75.00
April.....	240.00	90.00	64.37	120.00	107.50	115.00	88.00	100.00	100.00	105.00	94.00	80.00	75.00	68.00	85.00	85.00	75.00
May.....	250.00	85.00	66.87	128.00	107.50	115.00	88.00	94.00	103.00	105.00	94.00	80.00	75.00	68.00	85.00	85.00	75.00
June.....	225.00	80.00	67.50	128.75	107.50	115.00	88.00	90.00	105.00	105.00	94.00	80.00	68.00	68.00	85.00	85.00	75.00
July.....	225.00	70.60	67.50	*119.50	106.50	115.00	88.00	90.00	105.00	105.00	94.00	80.00	68.00	82.00	85.00	85.00	75.00
Aug.....	198.75	70.00	67.50	117.50	95.75	115.00	88.00	90.00	105.00	105.00	94.00	80.00	68.00	82.00	85.00	85.00	75.00
Sept.....	170.00	65.80	75.63	*111.25	90.00	115.00	88.00	90.00	105.00	105.00	94.00	80.00	68.00	82.00	85.00	85.00	75.00
Oct.....	170.00	63.00	100.00	*110.00	90.00	115.00	88.00	90.00	105.00	105.00	94.00	80.00	68.00	82.00	85.00	85.00	75.00
Nov.....	170.00	61.50	100.00	*108.75	98.75	115.00	96.60	90.00	105.00	105.00	94.00	80.00	68.00	82.00	85.00	85.00	80.00
Dec.....	135.00	60.00	100.00	*108.25	107.00	115.00	100.00	100.00	105.00	105.00	82.80	73.60	68.00	82.00	85.00	85.00	80.00
Aver.....	193.21	79.53	74.22	114.85	102.85	114.79	95.02	94.60	103.17	106.00	93.70	79.47	70.92	75.00	85.00	85.00	75.83

\*Price at furnace, where lower than price at seaboard.

### Spiegeleisen (19 to 21 Per Cent), Gross Ton, at Furnace

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$51.40	\$45.00	\$26.00	\$34.40	\$38.00	\$33.00	\$32.00	\$37.00	\$30.80	\$31.00	\$31.00	\$28.00	\$26.00	\$24.00	\$27.00	\$28.00	\$26.00
Feb.....	58.75	40.00	38.00	35.50	38.00	33.00	32.00	37.00	31.00	31.00	31.00	28.00	26.00	24.00	27.00	26.00	26.00
March.....	60.00	35.00	29.40	40.00	38.00	33.00	32.00	37.00	31.00	31.00	31.00	28.00	26.00	24.00	26.50	26.00	26.00
April.....	67.60	34.00	32.25	45.00	36.80	33.00	32.00	37.00	31.00	31.00	31.00	28.00	26.00	24.00	26.00	26.00	26.00
May.....	75.00	32.00	35.00	52.50	36.00	33.00	32.00	36.25	31.00	31.00	31.00	28.00	26.00	24.00	26.00	26.00	26.00
June.....	75.00	32.00	36.00	48.50	35.00	32.80	32.00	35.50	31.00	31.00	31.00	28.00	25.75	24.00	26.00	26.00	26.00
July.....	75.00	27.00	36.00	44.00	34.20	32.00	32.00	33.50	31.00	31.00	31.00	28.00	25.00	27.00	26.00	26.00	26.00
Aug.....	80.00	26.00	37.80	46.75	32.50	32.00	32.00	33.00	32.50	31.00	31.00	28.00	25.00	27.00	26.00	26.00	26.00
Sept.....	82.00	26.00	38.25	43.75	31.40	31.60	32.00	33.00	33.00	31.00	31.00	28.00	25.00	27.00	26.00	26.00	26.00
Oct.....	81.88	26.00	38.00	43.75	30.75	31.25	32.00	30.75	33.00	31.00	31.00	28.00	25.00	27.00	26.00	26.00	26.00
Nov.....	75.62	26.00	37.50	41.25	30.25	32.00	37.40	30.00	30.00	31.00	30.50	28.00	24.40	27.00	26.00	26.00	26.00
Dec.....	59.10	26.00	37.50	39.00	32.00	32.00	36.50	30.00	31.00	31.00	28.40	26.20	24.00	27.00	26.00	26.00	26.00
Aver.....	70.11	31.25	34.21	42.87	34.41	32.40	32.83	34.17	31.36	31.00	30.74	27.85	25.35	25.50	26.21	26.00	26.00

### 50 Per Cent Ferrosilicon, Gross Ton, Delivered East of Mississippi River

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$75.00	\$54.00	\$82.50	\$75.00	\$82.50	\$85.00	\$85.00	\$83.50	\$83.50	\$83.50	\$83.50	\$77.50	\$74.50	\$77.50	\$77.50	\$77.50
Feb.....	93.00	55.00	83.75	75.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	77.50
March.....	92.40	55.00	90.00	75.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	77.50
April.....	86.25	55.00	92.50	75.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	77.50
May.....	76.40	55.00	94.50	75.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	77.50
June.....	69.75	55.00	90.00	75.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	77.50
July.....	66.00	55.00	82.50	71.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	69.50
Aug.....	60.80	55.00	82.50	71.25	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	69.50
Sept.....	60.00	55.00	82.50	72.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	69.50
Oct.....	58.50	67.00	81.00	71.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	69.50
Nov.....	55.80	75.00	80.63	70.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	69.50
Dec.....	56.00	82.50	76.25	75.00	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.50	74.50	77.50	77.50	69.50
Aver.....	70.83	59.88	84.89	75.35	82.50	85.00	85.00	83.50	83.50	83.50	83.50	77.60	74.60	77.60	77.60	73.60

## Connellsville Coke Prices

### Prompt Connellsville Furnace Coke, Net Ton at Oven

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$9.50	\$6.00	\$5.65	\$6.00	\$5.06	\$2.75	\$8.05	\$3.94	\$3.94	\$7.19	\$3.50	\$2.70	\$2.75	\$2.55	\$2.50	\$2.25	\$1.75	\$3.60	\$3.85	\$3.65
Feb.....	9.62	6.00	4.44	6.00	4.50	3.04	7.13	4.03	3.63	7.31	3.38	2.68	2.90	2.60	2.50	2.25	1.75	3.50	3.85	3.65
March.....	9.60	6.00	4.06	6.00	4.35	3.25	7.25	4.03	3.35	3.05	3.35	2.60	2.98	2.60	2.50	2.25	1.75	3.50	3.85	3.65
April.....	7.38	6.00	3.65	9.60	3.50	4.48	6.31	3.75	3.04	3.00	3.20	2.60	2.78	2.60	2.50	2.25	1.75	3.85	3.85	3.65
May.....	7.80	6.00	3.69	12.00	3.25	6.00	5.15	3.25	3.00	2.91	2.94	2.60	2.75	2.53	2.45	2.20	1.75	3.85	3.85	3.65
June.....	11.25	6.00	4.00	15.00	3.00	6.75	4.75	3.19	2.77	2.83	2.93	2.60	2.75	2.50	2.40	2.00	1.81	3.85	3.59	3.65
July.....	12.75	6.00	4.07	17.20	2.81	10.75	4.55	3.00	2.83	2.84	3.00	2.63	2.75	2.50	2.40	2.00	2.31	3.85	3.27	3.50
Aug.....	13.60	6.00	4.31	17.75	2.75	12.80	4.56	3.00	3.06	2.95	3.00	2.75	2.73	2.58	2.40	2.00	2.55	3.85	3.29	3.61
Sept.....	11.12	6.00	4.56	16.70	3.15	11.13	4.50	3.00	3.49	3.38	2.85	2.75	2.65	2.60	2.40	2.00	2.50	3.85	3.25	3.69
Oct.....	6.00	6.00	4.52	15.12	3.28	9.60	3.85	3.00	6.13	3.63	2.85	2.83	2.65	2.60	2.40	1.81	3.50	3.85	3.53	3.75
Nov.....	6.00	6.00	5.87	8.26	3.03	7.19	3.81	3.04	5.75	4.43	2.77	2.75	2.65	2.53	2.40	1.75	3.75	3.85	3.60	3.75
Dec.....	6.00	6.00	6.12	6.20	2.75	7.00	4.00	3.68	4.32	3.50	2.75	2.75	2.63	2.50	2.34	1.75	3.75	3.85	3.57	3.92
Aver.....	9.22	6.00	4.58	11.32	3.45	7.01	5.53	3.42	3.78	3.92	3.04	2.69	2.75	2.56	2.43	2.04	2.41	3.79	3.61	3.68

### Prompt Connellsville Foundry Coke, Net Ton at Oven

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$9.75	\$7.00	\$6.25	\$7.00	\$6.38	\$3.75	\$8.70	\$4.75	\$4.88	\$7.75	\$4.50	\$3.75	\$3.75	\$3.50	\$3.50	\$3.50	\$2.50	\$4.25	\$4.60	\$4.25
Feb.....	11.00	7.00	5.00	7.00	5.63	4.00	8.25	4.88	4.31	8.31	4.31	3.75	3.75	3.50	3.50	3.50	2.50	4.25	4.60	4.25
March.....	11.60	7.00	4.94	7.00	5.45	4.25	8.38	4.88	4.15	4.40	4.40	3.75	3.75	3.50	3.50	3.50	2.50	4.25	4.60	4.25
April.....	9.13	7.00	4.30	10.20	4.75	5.06	7.56	4.75	4.00	4.06	4.06	3.75	3.75	3.50	3.50	3.50	2.50	4.60	4.60	4.25
May.....	8.90	7.00	4.31	13.00	4.50	6.30	6.15	4.69	4.00	4.00	4.00	3.75	3.75	3.50	3.50	3.10	2.50	4.60	4.60	4.25
June.....	11.72	7.00	4.56	15.75	4.45	7.25	5.56	4.38	4.80	4.00	4.00	3.75	3.75	3.50	3.50	3.00	2.56	4.60	4.15	4.25
July.....	13.25	7.00	5.00	17.80	4.06	11.00	5.35	4.10	3.75	4.00	4.00	3.75	3.75	3.50	3.50	3.00	2.94	4.60	3.88	4.00
Aug.....	13.20	7.00	5.25	18.88	3.75	13.90	5.38	4.00	3.88	4.00	4.00	3.75	3.75	3.50	3.50	2.90	3.15	1.60	4.00	4.00
Sept.....	11.75	7.00	5.80	17.70	4.15	12.50	5.50	4.00	4.25	4.38	4.00	3.75	3.75	3.50	3.50	2.75	3.25	1.60	4.00	4.05
Oct.....	6.00	7.00	6.25	17.38	4.38	11.70	4.80	4.00	6.31	4.63	4.00	3.75	3.75	3.50	3.50	2.75	4.05	4.60	4.20	4.25
Nov.....	7.00	7.00	7.00	9.50	4.19	8.38	4.81	4.06	6.81	5.50	3.85	3.75	3.75	3.50	3.50	2.75	4.25	4.60	4.25	4.25
Dec.....	7.00	7.00	7.00	7.00	3.81	7.88	4.81	4.55	5.20	4.50	3.75	3.75	3.50	3.50	3.25	2.69	4.25	4.60	4.15	4.40
Aver.....	10.03	7.00	6.47	12.87	4.63	8.00	6.27	4.42	4.61	4.96	4.11	3.75	3.73	3.60	3.48	3.08	3.08	4.51	4.20	4.20

Average of THE IRON AGE quotations on steel bars, shapes, sheets for period prior to 1920; hot-rolled strip and

	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Jan.....	1.911	2.026	1.921	1.740	1.713	1.747	1.887	1.923	1.820	1.741	1.615	1.424	1.771	1.451	1.383	2.060	3.384	3.549
Feb.....	1.935	2.005	1.875	1.751	1.725	1.749	1.899	1.920	1.772	1.736	1.620	1.400	1.766	1.477	1.395	2.203	3.501	3.549
March.....	1.992	2.075	1.886	1.769	1.783	1.746	1.905	1.920	1.599	1.727	1.623	1.394	1.786	1.473	1.413	2.447	3.739	3.549
April.....	2.045	2.083	1.886	1.764	1.793	1.741	1.931	1.920	1.577	1.727	1.627	1.433	1.790	1.446	1.437	2.611	4.110	3.549
May.....	2.042	2.064	1.886	1.757	1.799	1.741	1.933	1.920	1.506	1.720	1.620	1.456	1.727	1.424	1.433	2.750	4.562	3.549
June.....	2.034	2.070	1.886	1.737	1.779	1.763	1.927	1.851	1.506	1.707	1.556	1.470	1.687	1.399	1.444	2.689	5.004	3.549
July.....	2.005	2.106	1.884	1.702	1.779	1.763	1.927	1.820	1.543	1.657	1.546	1.504	1.667	1.400	1.471	2.640	5.334	3.549
Aug.....	2.080	2.136	1.879	1.674	1.783	1.763	1.927	1.820	1.581	1.636	1.539	1.553	1.624	1.446	1.511	2.682	5.249	3.549
Sept.....	2.249	2.126	1.871	1.621	1.786	1.763	1.934	1.820	1.616	1.627	1.513	1.610	1.591	1.470	1.559	2.765	5.049	3.549
Oct.....	2.087	2.047	1.867	1.620	1.720	1.780	1.934	1.820	1.664	1.613	1.441	1.659	1.559	1.446	1.634	2.856	3.470	3.55
Nov.....	2.056	1.991	1.812	1.652	1.723	1.820	1.934	1.820	1.674	1.613	1.407	1.700	1.505	1.397	1.769	3.021	3.444	3.549
Dec.....	2.047	1.953	1.761	1.691	1.727	1.870	1.934	1.820	1.727	1.611	1.399	1.725	1.463	1.366	1.941	3.278	3.441	3.461
<b>Aver.....</b>	<b>2.040</b>	<b>2.057</b>	<b>1.868</b>	<b>1.707</b>	<b>1.760</b>	<b>1.770</b>	<b>1.923</b>	<b>1.865</b>	<b>1.632</b>	<b>1.676</b>	<b>1.612</b>	<b>1.527</b>	<b>1.661</b>	<b>1.433</b>	<b>1.533</b>	<b>2.667</b>	<b>4.191</b>	<b>3.549</b>

## Open-Hearth Steel Billets at Pittsburgh, Gross Ton

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$48.00	\$43.50	\$28.00	\$37.50	\$40.00	\$38.00	\$35.00	\$35.00	\$33.00	\$33.00	\$34.00	\$30.00	\$27.75	\$26.00	\$26.00	\$27.00	\$29.00
Feb.....	55.25	41.00	28.00	39.63	40.00	38.00	35.00	33.00	33.00	33.25	33.00	30.00	27.00	26.00	26.00	27.00	29.00
March.....	60.00	38.50	28.00	44.39	40.00	36.70	35.00	34.00	33.00	34.00	33.00	30.00	27.00	26.00	26.00	27.00	28.20
April.....	60.00	37.50	29.50	45.00	40.00	35.50	35.00	33.25	33.00	34.80	33.00	30.00	27.00	26.00	26.75	27.00	28.00
May.....	60.00	37.00	34.00	45.00	38.50	35.25	35.00	33.00	33.00	36.00	32.50	29.50	27.00	26.00	29.00	27.00	28.00
June.....	61.00	37.00	35.00	42.63	38.00	35.00	35.00	33.00	32.25	35.25	31.00	29.00	26.50	26.00	29.00	27.00	28.00
July.....	65.00	32.25	35.00	42.50	38.00	35.00	35.00	33.00	32.00	35.00	31.00	29.00	26.00	26.00	27.40	27.00	30.00
Aug.....	61.00	29.00	35.50	42.50	37.75	35.00	35.00	33.00	32.00	35.00	31.00	29.00	26.00	26.00	27.00	27.00	30.00
Sept.....	58.75	29.00	39.50	41.83	36.40	35.00	35.00	33.00	32.00	35.00	31.00	29.00	26.00	26.00	27.00	27.00	30.00
Oct.....	55.00	29.00	40.00	40.00	35.75	34.25	35.00	33.00	32.80	35.00	31.00	29.00	26.00	26.00	27.00	27.00	32.00
Nov.....	49.70	29.00	37.75	40.00	35.50	34.75	35.00	33.00	33.00	35.00	31.00	29.00	26.00	26.00	27.00	28.00	32.00
Dec.....	43.50	29.00	36.50	44.00	36.00	35.00	35.00	33.00	33.00	34.60	30.60	28.80	26.00	26.00	27.00	29.00	32.00
<i>Aver.....</i>	<i>56.43</i>	<i>34.36</i>	<i>33.90</i>	<i>41.75</i>	<i>37.99</i>	<i>35.62</i>	<i>35.00</i>	<i>33.97</i>	<i>32.67</i>	<i>34.66</i>	<i>31.84</i>	<i>29.36</i>	<i>26.51</i>	<i>26.00</i>	<i>27.10</i>	<i>27.86</i>	<i>29.68</i>

### Wire Rods at Pittsburgh, Cross Ton

Quotations apply to both open-hearth and Bessemer rods

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$60.00	\$57.00	\$36.00	\$47.00	\$51.00	\$48.00	\$45.00	\$45.00	\$41.60	\$42.00	\$40.00	\$35.00	\$37.00	\$35.80	\$36.00	\$38.00	\$40.00
Feb.....	63.75	54.50	35.75	49.38	51.00	48.00	45.00	43.00	43.00	42.00	39.75	35.00	37.00	35.00	36.00	38.00	40.00
March.....	70.00	52.00	36.00	50.00	51.00	48.00	45.00	43.00	44.00	42.00	38.00	35.00	37.00	35.00	36.00	38.00	38.40
April.....	70.00	49.00	38.00	50.25	51.00	47.00	45.00	42.25	44.00	42.00	38.00	35.00	37.00	35.00	36.50	38.00	38.00
May.....	72.50	48.00	38.00	51.00	48.75	46.00	45.00	42.00	44.00	42.00	36.00	35.00	37.00	35.00	38.00	38.00	38.00
June.....	75.00	48.00	38.50	51.00	48.00	45.60	45.00	42.00	42.00	42.00	36.00	35.00	37.00	35.00	38.00	38.00	38.00
July.....	75.00	43.00	40.00	51.00	48.00	45.00	45.00	42.25	42.00	42.00	36.00	35.00	37.00	35.00	38.00	38.00	38.00
Aug.....	75.00	41.80	42.40	51.00	46.50	45.00	45.00	43.00	42.00	42.00	36.00	35.00	37.00	35.00	38.00	38.00	38.00
Sept.....	75.00	39.50	46.25	51.00	46.00	45.00	45.00	43.00	42.00	42.00	36.00	35.00	37.00	35.00	38.00	38.00	38.00
Oct.....	75.00	40.50	45.00	51.00	45.50	45.00	45.00	42.75	42.00	40.00	36.00	35.00	37.00	35.00	38.00	38.00	40.00
Nov.....	66.40	40.00	45.00	51.00	45.00	45.00	45.00	41.00	42.00	40.00	36.00	35.00	37.00	35.00	38.00	38.50	40.00
Dec.....	57.00	38.00	45.00	51.00	48.00	45.00	45.00	40.00	42.00	40.00	35.20	35.40	37.00	36.00	38.00	40.00	43.00
<i>Aver.....</i>	<i>69.55</i>	<i>45.94</i>	<i>40.49</i>	<i>60.39</i>	<i>48.81</i>	<i>46.05</i>	<i>45.00</i>	<i>42.44</i>	<i>42.55</i>	<i>41.50</i>	<i>36.91</i>	<i>35.03</i>	<i>37.00</i>	<i>35.15</i>	<i>37.37</i>	<i>38.21</i>	<i>39.12</i>

## Steel Rails at Mill, Open-Hearth, Gross Ton

The extra \$2 a gross ton, which was for many years charged for open-hearth rails, was annulled with the rail price announced Oct. 22, 1921

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$47.00	\$47.00	\$40.00	\$43.00	\$43.00	\$43.00	\$43.00	\$43.00	\$43.00	\$43.00	\$43.00	\$43.00	\$43.00	\$40.00	\$36.375	\$36.375	\$36.375
Feb.....	47.00	47.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.375	36.375	36.375
March.....	49.50	47.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.375	36.375	36.375
April.....	57.00	47.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.375	36.375	36.375
May.....	57.00	47.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.375	36.375	36.375
June.....	57.00	47.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.375	36.375	36.375
July.....	57.00	47.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.375	36.375	36.375
Aug.....	57.00	47.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.375	36.375	36.375
Sept.....	57.00	47.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.375	36.375	36.375
Oct.....	57.00	45.25	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	42.25	39.55	36.375	36.375	36.375
Nov.....	57.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.38	36.375	36.375	36.375
Dec.....	53.00	40.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	40.00	36.38	36.375	36.375	39.00
Aver.....	51.58	45.69	40.75	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.44	39.26	36.375	36.375	36.50

### Standard Steel Pipe at Pittsburgh, Net Ton

Computed from list discounts, for carload lots; price for base size pipe, 1 to 3 in.;  $\frac{3}{4}$  to 3 in. prior to April 13, 1931

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$80.64	\$77.30	\$51.87	\$61.13	\$70.30	\$70.30	\$70.30	\$70.30	\$68.60	\$70.30	\$70.30	\$66.50	\$64.84	\$65.00	\$61.75	\$68.40	\$68.40
Feb.....	83.36	76.85	51.87	66.50	70.30	70.30	70.30	70.30	68.60	70.30	70.30	66.50	64.84	65.00	61.75	68.40	64.98
March.....	83.36	76.88	51.87	46.50	70.30	70.30	70.30	70.30	68.60	70.30	70.30	66.50	64.84	65.00	61.75	68.40	61.80
April.....	83.36	71.63	51.87	68.02	70.30	70.30	70.30	70.30	69.88	70.30	66.50	66.50	64.84	58.00	63.41	68.40	61.00
May.....	83.36	67.62	51.87	70.30	70.30	70.30	70.30	70.30	70.30	70.30	66.50	63.59	64.84	58.00	68.40	68.40	61.00
June.....	83.36	67.82	51.87	70.30	70.30	70.30	70.30	70.30	70.30	70.30	66.50	64.84	64.84	58.00	68.40	68.40	61.00
July.....	83.36	64.63	51.87	70.30	70.30	70.30	70.30	70.30	70.30	70.30	66.50	64.84	64.84	61.75	68.40	68.40	61.00
Aug.....	83.36	63.91	54.74	70.30	70.30	70.30	70.30	70.30	70.30	70.30	66.50	64.84	64.84	61.75	68.40	68.40	61.00
Sept.....	83.36	60.21	57.43	70.30	70.30	70.30	70.30	70.30	70.30	70.30	66.50	64.84	65.00	61.75	68.40	68.40	61.00
Oct.....	83.36	56.50	58.74	70.30	70.30	70.30	70.30	68.54	70.30	70.30	66.50	64.84	65.00	61.75	68.40	68.40	61.00
Nov.....	83.36	56.50	61.13	70.30	70.30	70.30	70.30	66.79	70.30	70.30	66.50	64.84	65.00	61.75	68.40	68.40	61.00
Dec.....	83.36	53.96	61.13	70.30	70.30	70.30	70.30	66.79	70.30	70.30	66.50	64.84	65.00	61.75	68.40	68.40	61.00
Aver.....	88.13	66.14	54.69	68.71	70.30	70.30	70.30	69.67	69.84	70.30	67.45	65.29	64.89	61.63	66.32	68.40	62.01

# Weekly Market Quotations In THE IRON AGE

## Finished Steel

plates, plain wire, open-hearth rails, black pipe and black  
ded for subsequent period. Quoted in cents a pound

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	3.371	3.202	3.087	2.052	2.494	2.81	2.521	2.429	2.365	2.224	2.266	2.231	2.032	1.937	1.930	2.008	2.124	2.130
Feb.....	3.371	3.628	2.965	2.002	2.637	2.808	2.521	2.412	2.296	2.271	2.286	2.212	2.037	1.926	1.923	2.008	2.124	2.109
March.....	3.282	3.916	2.787	1.995	2.768	2.767	2.52	2.416	2.302	2.273	2.286	2.215	2.032	1.939	1.923	2.008	2.124	2.089
April.....	3.031	4.08	2.74	2.063	2.87	2.696	2.465	2.421	2.296	2.27	2.317	2.158	2.024	1.97	1.873	2.056	2.124	2.097
May.....	3.021	4.015	2.762	2.123	2.856	2.647	2.427	2.401	2.296	2.249	2.317	2.124	2.012	1.97	1.877	2.199	2.124	2.097
June.....	3.021	3.974	2.64	2.18	2.852	2.596	2.41	2.405	2.304	2.236	2.317	2.11	2.008	1.971	1.895	2.199	2.124	2.097
July.....	3.021	4.087	2.523	2.211	2.832	2.555	2.405	2.415	2.302	2.222	2.317	2.079	2.024	1.976	1.953	2.141	2.124	2.159
Aug.....	3.021	4.171	2.346	2.325	2.802	2.494	2.39	2.415	2.302	2.242	2.307	2.062	2.014	1.971	1.958	2.124	2.124	2.159
Sept.....	3.004	4.165	2.239	2.461	2.802	2.457	2.372	2.39	2.293	2.242	2.301	2.053	2.014	1.965	1.962	2.124	2.124	2.167
Oct.....	3.052	3.987	2.206	2.516	2.802	2.437	2.382	2.399	2.246	2.263	2.28	2.038	2.013	1.97	2.013	2.124	2.130	2.197
Nov.....	3.084	3.717	2.131	2.49	2.802	2.452	2.416	2.402	2.216	2.274	2.273	2.035	2.008	1.948	1.995	2.124	2.130	2.197
Dec.....	3.11	3.18	2.094	2.471	2.786	2.504	2.431	2.402	2.217	2.281	2.273	2.021	1.978	1.948	2.008	2.124	2.130	*2.282
Aver.....	\$3.115	\$3.843	\$2.543	\$2.241	\$2.775	\$2.802	\$2.438	\$2.409	\$2.286	\$2.254	\$2.297	\$2.111	\$2.016	1.957	1.943	\$2.103	\$2.186	\$2.182

\*Preliminary.

## Structural Shapes at Pittsburgh, Cents a Pound

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	3.25	3.00	2.80	2.47	2.45	1.50	2.06	2.50	2.10	1.90	1.98	1.81	1.90	1.83	1.64	1.50	1.60	1.70	1.80	1.80
Feb.....	3.25	3.00	2.80	2.70	2.26	1.39	2.20	2.50	2.10	1.90	1.90	1.85	1.90	1.80	1.65	1.50	1.60	1.70	1.80	1.80
March.....	3.54	3.00	2.71	3.13	2.08	1.39	2.39	2.39	2.10	1.90	1.90	1.85	1.90	1.80	1.65	1.52	1.60	1.70	1.80	1.80
April.....	3.88	3.00	2.45	3.25	2.10	1.50	2.50	2.29	2.05	1.90	1.88	1.85	1.95	1.80	1.65	1.60	1.60	1.74	1.80	1.80
May.....	4.00	3.00	2.45	3.10	2.20	1.56	2.50	2.24	2.00	1.90	1.80	1.85	1.95	1.73	1.65	1.60	1.60	1.85	1.80	1.80
June.....	4.31	3.00	2.45	3.10	2.10	1.63	2.50	2.20	2.00	1.94	1.80	1.85	1.95	1.69	1.65	1.60	1.60	1.85	1.80	1.80
July.....	4.50	3.00	2.45	3.10	1.93	1.70	2.50	2.09	2.00	1.80	1.85	1.95	1.95	1.65	1.63	1.60	1.60	1.81	1.80	1.90
Aug.....	4.30	3.00	2.45	3.10	1.82	1.88	2.50	2.00	1.95	2.00	1.80	1.90	1.95	1.61	1.60	1.60	1.60	1.80	1.80	1.90
Sept.....	4.00	3.00	2.45	3.10	1.64	2.00	2.50	2.00	1.90	2.00	1.78	1.90	1.95	1.60	1.60	1.60	1.60	1.80	1.80	1.90
Oct.....	3.00	3.00	2.45	3.05	1.60	2.00	2.50	1.93	1.90	2.00	1.75	1.90	1.90	1.60	1.60	1.60	1.60	1.70	1.80	1.90
Nov.....	3.00	3.00	2.45	2.89	1.54	2.00	2.50	2.00	1.90	2.00	1.77	1.90	1.90	1.60	1.60	1.60	1.60	1.70	1.80	1.90
Dec.....	3.00	2.90	2.45	2.45	1.50	2.00	2.50	2.10	1.90	2.00	1.80	1.90	1.90	1.60	1.60	1.60	1.60	1.70	1.80	1.90
Aver.....	3.67	2.99	2.52	2.95	1.94	1.71	2.43	2.19	1.99	1.95	1.83	1.87	1.92	1.69	1.62	1.57	1.68	1.78	1.80	1.85

## Plates at Pittsburgh, Cents a Pound

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	4.45	3.25	3.00	2.72	2.65	1.48	2.06	2.50	2.00	1.86	1.90	1.81	1.90	1.83	1.64	1.50	1.60	1.70	1.80	1.80
Feb.....	4.88	3.25	3.00	3.50	2.33	1.39	2.23	2.45	2.00	1.80	1.86	1.85	1.90	1.80	1.65	1.50	1.60	1.70	1.80	1.80
March.....	5.25	3.25	2.91	3.63	2.04	1.39	2.39	2.39	2.00	1.86	1.85	1.85	1.90	1.80	1.65	1.52	1.60	1.70	1.80	1.80
April.....	5.88	3.25	2.65	3.75	2.10	1.48	2.50	2.28	2.00	1.90	1.85	1.85	1.95	1.80	1.65	1.60	1.55	1.74	1.80	1.80
May.....	6.60	3.25	2.65	3.75	2.20	1.56	2.50	2.20	2.00	1.86	1.84	1.85	1.95	1.73	1.65	1.60	1.50	1.85	1.80	1.80
June.....	8.00	3.25	2.65	3.55	1.95	1.63	2.50	2.18	1.92	1.88	1.80	1.85	1.95	1.69	1.65	1.60	1.53	1.85	1.80	1.80
July.....	9.00	3.25	2.65	3.38	1.85	1.70	2.50	2.09	1.90	1.90	1.80	1.85	1.95	1.65	1.63	1.60	1.60	1.81	1.80	1.90
Aug.....	8.80	3.25	2.65	3.25	1.78	1.88	2.50	1.95	1.85	1.90	1.80	1.90	1.95	1.61	1.60	1.60	1.60	1.80	1.80	1.90
Sept.....	8.00	3.25	2.53	3.25	1.64	2.13	2.50	1.82	1.80	1.90	1.78	1.90	1.95	1.60	1.60	1.60	1.60	1.80	1.80	1.90
Oct.....	3.25	3.25	2.61	3.09	1.60	2.11	2.50	1.80	1.80	1.90	1.75	1.90	1.94	1.60	1.60	1.60	1.60	1.70	1.80	1.90
Nov.....	3.25	3.25	2.65	2.81	1.54	1.99	2.50	1.83	1.86	1.90	1.77	1.90	1.90	1.60	1.60	1.60	1.60	1.70	1.80	1.90
Dec.....	3.25	3.13	2.65	2.65	1.50	1.95	2.50	1.92	1.90	1.90	1.80	1.90	1.90	1.60	1.54	1.60	1.60	1.70	1.80	1.90
Aver.....	5.88	3.24	2.72	3.28	1.93	1.72	2.43	2.12	1.91	1.88	1.82	1.87	1.93	1.69	1.62	1.57	1.61	1.78	1.80	1.85

## Soft Steel Bars at Pittsburgh, Cents a Pound

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	3.15	2.90	2.70	2.75	2.35	1.50	2.04	2.40	2.10	2.00	1.98	1.81	1.90	1.89	1.64	1.50	1.60	1.75	1.80	1.85
Feb.....	3.25	2.90	2.70	3.00	2.15	1.39	2.20	2.40	2.10	2.00	1.90	1.85	1.90	1.85	1.65	1.50	1.60	1.75	1.80	1.85
March.....	3.63	2.90	2.61	3.63	2.00	1.39	2.39	2.40	2.10	2.00	1.90	1.85	1.90	1.85	1.65	1.52	1.60	1.75	1.80	1.85
April.....	3.75	2.90	2.35	3.75	2.05	1.50	2.50	2.29	2.05	2.00	1.89	1.85	1.95	1.79	1.65	1.60	1.60	1.79	1.80	1.85
May.....	4.00	2.90	2.35	3.63	2.10	1.58	2.40	2.24	2.00	1.95	1.85	1.85	1.95	1.75	1.65	1.60	1.60	1.90	1.80	1.85
June.....	4.25	2.90	2.35	3.50	2.05	1.70	2.40	2.20	2.00	2.00	1.81	1.85	1.95	1.73	1.65	1.60	1.60	1.90	1.80	1.85
July.....	4.50	2.90	2.35	3.50	1.84	1.70	2.40	2.15	2.00	2.00	1.80	1.85	1.95	1.65	1.63	1.60	1.60	1.82	1.80	1.95
Aug.....	4.30	2.90	2.35	3.25	1.74	1.88	2.40	2.13	1.95	2.00	1.80	1.90	1.95	1.64	1.60	1.60	1.60	1.80	1.80	1.95
Sept.....	4.00	2.90	2.35	3.25	1.63	2.00	2.40	2.04	1.92	2.00	1.78	1.90	1.94	1.61	1.60	1.60	1.60	1.80	1.80	1.97
Oct.....	2.90	2.90	2.39	3.13	1.55	2.00	2.40	2.00	2.00	2.00	1.75	1.91	1.90	1.60	1.60	1.60	1.60	1.75	1.80	2.05
Nov.....	2.90	2.90	2.69	2.87	1.50	2.00	2.40	2.03	2.00	2.00	1.77	1.94	1.90	1.60	1.60	1.60	1.60	1.75	1.80	2.05
Dec.....	2.90	2.80	2.75	2.35	1.50	2.00	2.40	2.10	2.00	2.00	1.80	1.90	1.90	1.60	1.58	1.60	1.60	1.75	1.80	2.05
Aver.....	3.63	2.89	2.50	3.22	1.87	1.72	2.36	2.20	2.02	2.00	1.84	1.87	1.92	1.71	1.63	1.57	1.64	1.81	1.81	1.93

## Cold-Finished Steel Bars at Pittsburgh, Cents a Pound

	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	2.20	2.20	2.15	2.08	2.00	1.70	2.10	2.10	2.10
Feb.....	2.20	2.20	2.10	2.10	2.00	1.70	2.10	2.10	2.10
March.....	2.20	2.20	2.10	2.10	2.00	1.70	2.10	2.10	2.10
April.....	2.20	2.30	2.10	2.10	2.00	1.70	2.10	2.01	2.10
May.....	2.20	2.30	2.10	2.10	1.82	1.70	2.10	1.95	2.10
June.....	2.20	2.30	2.10	2.10	1.70	1.70	2.10	1.95	2.10
July.....	2.10	2.30	2.10	2.10	1.70	1.70	2.10	1.95	2.25
Aug.....	2.10	2.30	2.10	2.10	1.70	1.70	2.10	1.95	2.25
Sept.....	2.10	2.30	2.10	2.10	1.70	1.95	2.10	1.95	2.25
Oct.....	2.16	2.30	2.10	2.10	1.70	1.95	2.10	1.95	2.35
Nov.....	2.20	2.30	2.00	2.10	1.70	1.95	2.10	1.95	2.35
Dec.....	2.20	2.30	2.00	2.02	1.70	2.10	2.10	1.95	2.35
Aver.....	2.17	2.28	2.09	2.09	1.81	1.80	2.10	1.99	2.20

### No. 24 Gage Galvanized Sheets, at Pittsburgh, Cents a Pound

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	6.25	6.25	6.05	5.33	5.70	4.00	4.35	4.98	4.75	4.60	3.78	3.65	3.60	3.33	2.90	2.80	2.68	2.85	3.10	3.10
Feb.....	6.38	6.25	6.05	5.50	5.56	4.00	4.54	5.00	4.75	4.53	3.71	3.65	3.60	3.30	2.90	2.75	2.50	2.85	3.10	3.10
March.....	6.69	6.25	5.96	7.00	5.05	4.00	4.93	4.93	4.62	4.50	3.65	3.65	3.60	3.30	2.90	2.85	2.60	2.85	3.10	3.10
April.....	7.00	6.25	5.70	7.00	4.88	4.11	5.25	4.88	4.45	4.50	3.63	3.65	3.60	3.30	2.84	2.85	2.63	2.95	3.10	3.10
May.....	8.20	6.25	5.70	7.00	5.00	4.15	5.20	4.80	4.29	4.43	3.72	3.58	3.60	3.33	2.80	2.85	2.70	3.25	3.10	3.10
June.....	9.50	6.25	5.70	7.00	4.88	4.15	5.00	4.76	4.21	4.28	3.85	3.50	3.60	3.19	2.74	2.85	2.70	3.25	3.10	3.10
July.....	10.00	6.25	5.70	8.25	4.31	4.15	5.00	4.56	4.19	4.24	3.85	3.46	3.60	3.13	2.90	2.85	2.85	3.13	3.10	3.20
Aug.....	10.00	6.25	5.70	9.00	3.90	4.23	5.00	5.55	4.20	4.23	3.85	3.40	3.50	3.05	2.90	2.81	2.85	3.10	3.10	3.20
Sept.....	9.75	6.25	5.70	8.88	3.81	4.35	5.00	4.60	4.20	*3.83	3.85	3.40	3.50	3.00	2.90	2.75	2.85	3.10	3.10	3.20
Oct.....	.....	6.25	5.70	8.18	4.00	4.50	5.00	4.60	4.23	3.85	3.76	3.50	3.50	2.99	2.90	2.85	2.85	3.10	3.10	3.20
Nov.....	6.25	6.25	5.70	7.04	3.86	4.43	4.93	4.60	4.50	3.85	3.66	3.50	3.48	2.95	2.90	2.85	2.85	3.10	3.10	3.20
Dec.....	6.25	6.15	5.70	5.70	4.00	4.35	4.89	4.72	4.60	3.85	3.63	3.58	3.40	2.92	2.86	2.85	2.85	3.10	3.10	3.40
Aver.....	7.84	6.24	5.78	7.24	4.53	4.20	4.92	4.75	4.48	3.89	3.76	3.54	3.55	3.14	2.87	2.83	2.74	3.06	3.10	3.17

\*No. 24 gage was made the base in September, 1926. Quotations prior to that time are for No. 28 gage, for which there is now an extra of 50c. per 100 lb.

### No. 24 Hot-Rolled Annealed Sheets, at Pittsburgh, Cents a Pound

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	4.50	5.00	4.70	4.43	4.35	3.00	3.35	3.83	3.60	3.35	2.91	2.80	2.85	2.65	2.35	2.22	2.02	2.25	2.40	2.40
Feb.....	4.69	5.00	4.70	5.00	4.21	3.00	3.46	3.85	3.50	3.27	2.80	2.90	2.85	2.61	2.35	2.15	2.00	2.25	2.40	2.40
March.....	4.94	5.00	4.61	5.50	3.88	3.00	3.71	3.78	3.44	3.25	2.75	2.89	2.85	2.65	2.31	2.19	2.00	2.25	2.40	2.40
April.....	5.75	5.00	4.35	5.50	3.88	3.11	4.00	3.71	3.35	3.25	2.74	2.77	2.85	2.55	2.25	2.20	2.00	2.35	2.40	2.40
May.....	7.00	5.00	4.35	5.50	4.00	3.15	3.88	3.60	3.20	3.17	2.86	2.71	2.85	2.55	2.15	2.20	2.04	2.65	2.40	2.40
June.....	7.88	5.00	4.35	5.50	3.80	3.15	3.85	3.53	3.15	3.10	3.00	2.65	2.85	2.55	2.20	2.20	2.10	2.65	2.40	2.40
July.....	8.50	5.00	4.35	6.75	3.31	3.15	3.81	3.46	3.13	3.10	3.00	2.62	2.85	2.49	2.40	2.20	2.25	2.47	2.40	2.50
Aug.....	8.50	5.00	4.34	7.50	2.90	3.23	3.75	3.45	3.15	3.10	3.00	2.65	2.85	2.44	2.40	2.16	2.25	2.40	2.40	2.50
Sept.....	8.50	5.00	4.35	7.38	2.81	3.35	3.75	3.50	3.14	*2.90	3.00	2.65	2.85	2.42	2.40	2.10	2.25	2.40	2.40	2.50
Oct.....	.....	5.05	4.35	6.69	3.00	3.47	3.75	3.50	3.11	2.97	2.90	2.75	2.77	2.36	2.40	2.17	2.25	2.40	2.40	2.60
Nov.....	5.00	5.00	4.35	5.77	2.86	3.35	3.75	3.50	3.25	3.00	2.78	2.75	2.75	2.35	2.40	2.10	2.25	2.40	2.40	2.60
Dec.....	5.00	4.85	4.35	4.35	3.00	3.35	3.75	3.54	3.33	3.00	2.77	2.83	2.75	2.35	2.35	2.10	2.25	2.40	2.40	2.80
Aver.....	6.39	4.99	4.43	5.83	3.50	3.19	3.73	3.60	3.28	2.95	2.88	2.75	2.83	2.50	2.33	2.17	2.14	2.41	2.40	2.49

\*No. 24 gage was made the base in September, 1926; prices prior to that time are for No. 28 gage.

### Hot-Rolled Sheets, No. 10 Gage, at Pittsburgh, Cents a Pound

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	3.55	2.25	2.52	3.00	2.70	2.50	2.25	2.10	2.10	2.10	1.90	1.75	1.62	1.75	1.85	1.85
Feb.....	3.29	2.25	2.64	3.00	2.70	2.50	2.20	2.10	2.10	2.10	1.90	1.75	1.60	1.75	1.85	1.85
March.....	3.04	2.25	2.95	2.93	2.69	2.50	2.20	2.10	2.10	2.10	1.90	1.71	1.55	1.75	1.85	1.85
April.....	3.05	2.36	3.25	2.86	2.53	2.43	2.19	2.08	2.10	2.06	1.85	1.70	1.55	1.81	1.85	1.85
May.....	3.10	2.40	3.20	2.80	2.40	2.40	2.22	2.00	2.13	2.00	1.85	1.70	1.44	2.00	1.85	1.85
June.....	2.88	2.40	3.00	2.76	2.31	2.32	2.25	2.00	2.20	2.00	1.85	1.70	1.50	2.00	1.85	1.85
July.....	2.55	2.40	3.00	2.68	2.30	2.30	2.25	2.00	2.14	2.00	1.85	1.70	1.65	1.88	1.85	1.95
Aug.....	2.31	2.44	3.00	2.63	2.30	2.30	2.25	2.00	2.10	1.93	1.85	1.70	1.65	1.85	1.85	1.95
Sept.....	2.23	2.44	3.00	2.69	2.25	2.30	2.25	2.00	2.10	1.90	1.85	1.70	1.68	1.85	1.85	1.95
Oct.....	2.25	2.60	3.00	2.70	2.26	2.30	2.14	2.00	2.10	1.90	1.85	1.70	1.75	1.85	1.85	1.95
Nov.....	2.25	2.55	3.00	2.70	2.40	2.30	2.10	2.00	2.10	1.90	1.85	1.70	1.75	1.85	1.85	1.95
Dec.....	2.25	2.50	3.00	2.70	2.50	2.30	2.10	2.08	2.18	1.90	1.80	1.70	1.75	1.85	1.85	2.15
Aver.....	2.73	2.41	2.96	2.79	2.45	2.37	2.20	2.04	2.12	1.99	1.86	1.71	1.62	1.85	1.85	1.92

### Automobile Body and Light Cold-Rolled Sheets, No. 20 Gage, at Pittsburgh, Cents a Pound

Automobile Body Classification Dropped in November, 1932. Quotations for 1933-36 are on Light Cold-Rolled Sheets

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	5.20	4.35	4.70	5.35	4.75	4.50	4.18	4.00	4.10	3.90	3.30	2.90	2.35	2.75	2.95	2.95
Feb.....	5.20	4.35	4.78	5.35	4.68	4.43	4.15	4.08	4.10	3.90	3.90	2.80	2.25	2.75	2.95	2.95
March.....	5.20	4.35	5.00	5.35	4.46	4.40	4.15	4.15	4.10	3.88	3.24	2.86	2.30	2.75	2.95	2.95
April.....	5.20	4.40	5.00	5.25	4.40	4.33	4.15	4.04	4.10	3.80	3.10	2.90	2.30	2.85	2.95	2.95
May.....	5.20	4.45	5.35	5.10	4.40	4.29	4.15	4.00	4.10	3.75	3.03	2.89	2.34	3.15	2.95	2.95
June.....	4.95	4.50	5.35	5.10	4.22	4.20	4.25	4.00	4.10	3.65	3.02	2.85	2.29	3.15	2.95	2.95
July.....	4.70	4.60	5.35	5.06	5.15	4.20	4.25	4.00	4.10	3.60	3.10	2.85	2.40	2.99	2.95	3.05
Aug.....	4.65	4.75	5.35	4.75	4.25	4.20	4.25	4.00	4.08	3.60	3.10	2.81	2.47	2.95	2.95	3.05
Sept.....	4.45	4.85	5.35	4.72	4.25	*4.25	4.25	4.00	4.00	3.60	3.10	2.75	2.75	2.95	2.95	3.05
Oct.....	4.55	4.85	5.35	4.60	4.29	4.25	4.15	4.00	4.00	3.45	3.10	2.65	2.75	2.95	2.95	3.05
Nov.....	4.35	4.85	5.35	4.60	4.40	4.25	4.12	4.00	4.00	3.38	3.10	2.63	2.75	2.95	2.95	3.05
Dec.....	4.35	4.70	5.25	4.75	4.50	4.25	4.00	4.08	3.98	3.30	3.02	2.65	2.75	2.95	2.95	3.25
Aver.....	4.83	4.68	5.19	5.00	4.39	4.30	4.17	4.03	4.06	3.64	3.13	2.80	2.43	2.96	2.95	3.02

\*No. 22 gage prior to Sept. 1, 1926.

### Tin Plate at Pittsburgh, Dollars a Base Box

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$7.00	\$7.75	\$7.35	\$7.00	\$7.00	\$4.75	\$4.75	\$5.50	\$5.50	\$5.50	\$5.50	\$5.25	\$5.35	\$5.25	\$5.00	\$4.75	\$4.25	\$5.25	\$5.25	\$5.25
Feb.....	7.38	7.75	7.35	7.00	7.00	4.71	4.80	5.50	5.50	5.50	5.50	5.25	5.35	5.25	5.00	4.75	4.25	5.25	5.25	5.25
March.....	8.00	7.75	7.26	7.00	7.00	4.60	5.23	5.50	5.50	5.50	5.50	5.25	5.35	5.25	5.00	4.75	4.25	5.25	5.25	5.25
April.....	8.00	7.75	7.00	7.00	6.44	4.75	6.00	5.50	5.50	5.50	5.50	5.25	5.35	5.25	5.00	4.75	4.25	5.25	5.25	5.25
May.....	8.40	7.75	7.00	7.00	6.25	4.75	5.70	5.50	5.50	5.50	5.50	5.25	5.35	5.25	5.00	4.75	4.25	5.25	5.25	5.25
June.....	10.50	7.75	7.00	7.00	6.25	4.75	5.50	5.50	5.50	5.50	5.50	5.25	5.35	5.25	5.00	4.75	4.25	5.25	5.25	5.25
July.....	12.00	7.75	7.00	7.50	5.69	4.75	5.50	5.50	5.50	5.50	5.50	5.25	5.35	5.25	5.00	4.75	4.25	5.25	5.25	5.25
Aug.....	11.40	7.75	7.00	9.00	5.25	4.75	5.50	5.50	5.50	5.50	5.50	5.25	5.35	5.25	5.00	4.75	4.25	5.25	5.25	5.25
Sept.....	12.00	7.75	7.00	9.00	5.25	4.75	5.50	5.50	5.50	5.50	5.50	5.25	5.35	5.25	5.00	4.75	4.25	5.25	5.25	5.25
Oct.....	.....	7.75	7.00	8.33	5.13	4.75	5.50	5.50	5.50	5.50	5.50	5.25	5.35	5.00	4.75	4.75	4.65	5.25	5.25	5.25
Nov.....	7.75	7.75	7.00	7.50	4.75	4.75	5.50	5.50	5.50	5.50	5.50	5.25	5.35	5.00	4.75	4.55	4.65	5.25	5.25	5.25
Dec.....	7.75	7.75	7.00	7.00	4.73	4.75	5.50	5.50	5.50	5.50	5.50	5.25	5.35	5.00	4.75	4.25	5.25	5.25	b 25	5.25
Aver.....	9.11	7.73	7.08	7.53	5.90	4.73	5.42	5.50	5.50	5.50	5.43	5.25	5.35	5.19	4.94	4.69	4.43	5.25	5.25	5.25

### Hot-Rolled Strip Steel, at Pittsburgh, Cents a Pound (Prices quoted only on strip wider than 6-in. prior to June 1, 1932.)

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	3.30	3.45	3.30	2.00	2.75	3.00	2.25	2.30	2.34	2.01	1.80	1.80	1.55	1.41	1.45	1.75	1.85	1.85
Feb.....	3.30	4.03	3.11	1.84	2.86	3.00	2.35	2.30	2.21	2.08	1.80	1.80	1.55	1.40	1.45	1.75	1.85	1.85
March.....	3.30	5.00	2.93	1.81	3.18	2.93	2.40	2.30	2.30	2.10	1.80	1.79	1.55	1.40	1.45	1.75	1.85	1.85
April.....	3.30	5.25	2.76	1.98	3.30	2.75	2.40	2.30	2.30	2.10	1.90	1.70	1.55	1.40	1.45	1.81	1.85	1.85
May.....	3.30	5.50	2.53	2.20	2.30	2.75	2.20	2.30	2.30	1.96	1.90	1.70	1.55	1.40	1.49	2.00	1.85	1.85
June.....	3.05	5.50	2.50	2.40	3.23	2.50	2.20	2.30	2.30	1.85	1.90	1.69	1.55	1.41	1.55	2.00	1.85	1.85
July.....	3.05	5.50	2.46	2.50	3.00	2.50	2.20	2.30	2.30	1.85	1.90	1.65	1.55	1.45	1.60	1.88	1.85	1.95
Aug.....	3.31	5.50	2.23	2.60	3.00	2.35	2.20	2.30	2.30	1.85	1.90	1.65	1.55	1.45	1.64	1.85	1.85	1.95
Sept.....	3.30	5.50	2.00	2.75	3.00	2.25	2.20	2.30	2.30	1.85	1.90	1.65	1.55	1.45	1.68	1.85	1.85	1.95
Oct.....	3.30	5.25	2.00	2.90	3.00	2.25	2.23	2.30	2.19	1.85	1.90	1.60	1.54	1.45	1.75	1.85	1.85	1.95
Nov.....	3.30	4.70	2.00	2.83	3.00	2.25	2.30	2.30	2.10	1.88	1.90	1.58	1.50	1.45	1.75	1.85	1.85	1.95
Dec.....	3.30	3.65	2.00	2.75	2.88	2.25	2.30	2.30	2.03	1.80	1.90	1.55	1.49	1.45	1.75	1.85	1.85	2.11
Aver.....	3.26	4.96	2.49	2.58	3.04	2.57	2.27	2.30	2.26	1.93	1.88	1.68	1.54	1.43	1.58	1.86	1.85	1.91

### Cold-Rolled Strip Steel, at Pittsburgh, Cents a Pound

	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	6.50	6.25	6.00	6.25	3.50	4.50	5.00	4.00	3.90	2.95	3.00	2.85	2.65	2.25	1.92	1.88	2.40	2.60	2.60
Feb.....	6.50	6.25	7.00	6.06	3.50	4.69	4.75	4.00	3.90	2.80	3.00	2.85	2.65	2.25	1.90	1.80	2.40	2.60	2.60
March.....	6.50	6.10	7.00	5.83	3.50	5.00	4.75	4.00	3.90	2.92	3.00	2.80	2.60	2.25	1.96	1.80	2.40	2.60	2.60
April.....	6.50	5.65	7.75	5.54	3.61	5.25	4.75	4.00	3.79	3.00	3.00	2.75	2.55	2.23	2.00	1.80	2.50	2.60	2.60
May.....	6.50	5.65	8.50	4.98	3.71	5.25	4.50	3.94	3.75	3.00	3.00	2.75	2.50	2.15	2.00	1.88	2.80	2.60	2.60
June.....	6.50	5.65	8.50	4.88	4.00	5.19	4.50	3.53	3.72	3.19	3.00	2.75	2.45	2.15	2.00	2.00	2.80	2.60	2.60
July.....	6.50	5.65	8.50	4.25	4.00	5.00	4.30	3.63	3.60	3.25	2.92	2.75	2.45	2.15	2.00	2.19	2.64	2.60	2.60
Aug.....	6.50	5.65	8.50	3.96	4.10	5.00	4.13	3.75	3.60	3.25	2.90	2.75	2.35	2.15	2.00	2.25	2.60	2.60	2.60
Sept.....	6.50	5.65	8.50	3.78	4.25	5.00	4.00	3.75	3.50	3.25	2.72	2.75	2.35	2.15	1.92	2.29	2.60	2.60	2.60
Oct.....	6.50	5.65	8.25	3.75	4.50	5.00	4.00	3.75	3.25	3.00	2.75	2.75	2.35	2.13	1.90	2.40	2.60	2.60	2.60
Nov.....	6.50	5.65	8.00	3.75	4.50	4.98	4.00	3.90	3.25	3.00	2.85	2.75	2.33	2.05	2.00	2.40	2.60	2.60	2.60
Dec.....	6.35	5.93	6.63	3.75	4.50	4.91	4.00	3.90	3.00	3.00	2.85	2.75	2.25	2.03	2.00	2.40	2.60	2.60	2.80
Aver.....	6.49	6.81	7.76	4.73	3.97	4.98	4.39	3.85	3.60	3.05	2.92	2.77	2.46	2.16	1.97	2.09	2.68	2.60	2.62

### Wire Nails at Pittsburgh, Keg of 100 Lb.

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$3.00	\$3.50	\$3.50	\$4.50	\$3.25	\$2.50	\$2.70	\$3.00	\$2.85	\$2.65	\$2.64	\$2.54	\$2.65	\$2.33	\$1.90	\$1.95	\$1.86	\$2.35	\$2.60	\$2.40
Feb.....	3.00	3.50	3.50	4.50	3.21	2.40	2.78	3.00	2.85	2.65	2.56	2.63	2.65	2.25	1.90	1.95	1.83	2.35	2.60	2.25
March.....	3.20	3.50	3.44	4.00	3.02	2.40	2.83	3.00	2.85	2.65	2.55	2.65	2.65	2.25	1.90	1.95	1.85	2.35	2.60	2.10
April.....	3.28	3.50	3.25	4.00	3.13	2.40	2.93	3.00	2.80	2.65	2.55	2.65	2.65	2.16	1.90	1.95	1.85	2.41	2.60	2.10
May.....	3.50	3.50	3.25	4.00	3.05	2.40	3.00	2.93	2.75	2.65	2.50	2.55	2.65	2.15	1.85	1.95	1.85	2.60	2.60	2.10
June.....	3.75	3.50	3.25	4.00	3.00	2.40	3.00	2.90	2.68	2.65	2.50	2.55	2.65	2.13	1.80	1.95	1.85	2.60	2.60	2.10
July.....	4.00	3.50	3.25	4.00	2.81	2.40	3.00	2.88	2.65	2.65	2.53	2.55	2.64	2.05	1.60	1.95	2.04	2.60	2.60	2.10
Aug.....	4.00	3.50	3.25	4.25	2.75	2.48	3.00	2.81	2.65	2.65	2.55	2.55	2.55	2.04	1.88	1.95	2.10	2.60	2.55	2.10
Sept.....	4.00	3.50	3.25	4.25	2.86	2.63	3.00	2.78	2.65	2.65	2.55	2.55	2.50	2.00	1.90	1.95	2.10	2.60	2.40	1.97
Oct.....	3.50	3.50	3.31	4.25	2.90	2.70	3.00	2.75	2.63	2.65	2.54	2.55	2.43	1.99	1.90	1.95	2.10	2.60	2.40	2.05
Nov.....	3.50	3.50	3.50	4.05	2.84	2.70	3.00	2.75	2.65	2.65	2.50	2.55	2.40	1.93	1.90	1.95	2.10	2.60	2.40	2.05
Dec.....	3.50	3.50	4.12	3.25	2.69	2.70	3.00	2.85	2.65	2.65	2.50	2.63	2.40	1.90	1.93	1.95	2.35	2.60	2.40	2.25
Aver.....	3.52	3.50	3.41	4.09	2.96	2.51	2.94	2.89	2.78	2.65	2.54	2.58	2.57	2.10	1.88	1.95	1.99	2.58	2.40	2.13

### Plain Wire, Base, at Pittsburgh, Cents a Pound

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	2.95	3.25	3.25	3.25	3.25	2.25	2.45	2.75	2.60	2.50	2.49	2.40	2.50	2.40	2.20	2.20	2.16	2.20	2.30	2.30
Feb.....	2.95	3.25	3.25	3.25	3.13	2.20	2.63	2.75	2.60	2.50	2.41	2.48	2.50	2.40	2.20	2.20	2.10	2.20	2.30	2.30
March.....	3.11	3.25	3.19	3.50	3.00	2.25	2.65	2.75	2.60	2.50	2.40	2.50	2.50	2.40	2.20	2.20	2.10	2.20	2.30	2.30
April.....	3.23	3.25	3.00	3.50	3.00	2.25	2.68	2.75	2.50	2.50	2.40	2.50	2.50	2.38	2.20	2.20	2.10	2.23	2.30	2.40
May.....	3.45	3.25	3.00	3.50	3.00	2.25	2.75	2.68	2.50	2.50	2.40	2.50	2.50	2.30	2.20	2.20	2.10	2.30	2.30	2.40
June.....	3.70	3.25	3.00	3.50	2.75	2.25	2.75	2.65	2.49	2.50	2.40	2.50	2.50	2.30	2.20	2.20	2.10	2.30	2.30	2.40
July.....	3.95	3.25	3.00	3.50	2.56	2.25	2.75	2.63	2.50	2.50	2.40	2.42	2.50	2.30	2.20	2.20	2.10	2.30	2.30	2.40
Aug.....	3.95	3.25	3.00	3.69	2.50	2.29	2.75	2.56	2.50	2.50	2.40	2.40	2.43	2.30	2.20	2.20	2.10	2.30	2.30	2.40
Sept.....	3.95	3.25	3.00	3.75	2.58	2.39	2.75	2.53	2.50	2.50	2.40	2.40	2.40	2.30	2.20	2.20	2.10	2.30	2.30	2.40
Oct.....	3.25	3.25	3.17	3.75	2.60	2.45	2.75	2.50	2.50	2.50	2.40	2.40	2.40	2.30	2.20	2.20	2.10	2.30	2.30	2.50
Nov.....	3.25	3.25	3.29	3.65	2.56	2.45	2.75	2.50	2.50	2.50	2.40	2.40	2.40	2.30	2.20	2.20	2.10	2.30	2.30	2.50
Dec.....	3.25	3.25	3.21	3.25	2.44	2.45	2.75	2.60	2.50	2.50	2.40	2.48	2.40	2.22	2.20	2.20	2.20	2.30	2.30	2.60
Aver.....	3.43	3.25	3.11	3.53	2.78	2.51	2.70	2.64	2.52	2.50	2.41	2.46	2.46	2.33	2.20	2.20	2.11	2.27	2.30	2.41

### Wrought Iron Pipe at Pittsburgh, Net Ton

Computed from list discounts, for carload lots; price for base size pipe, 1½ in.; 1½ and 2 in. prior to Oct. 1, 1932.

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.	\$115.60	\$135.06	\$100.96	\$122.56	\$131.10	\$131.10	\$127.82	\$127.82	\$127.82	\$118.56	\$118.56	\$118.56	\$118.56	\$120.00	\$113.00	\$113.00	\$113.00
Feb.	119.49	136.16	100.96	127.82	131.10	131.10	127.82	127.82	127.82	118.56	118.56	118.56	118.56	116.71	120.00	113.00	113.00
March	119.49	136.16	100.96	127.82	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	114.85	120.00	113.00	113.00
April	119.49	125.66	100.96	129.02	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	114.85	114.75	113.00	113.00
May	119.49	117.63	100.96	131.10	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	114.85	113.00	113.00	113.00
June	119.49	117.63	100.96	131.10	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	114.85	113.00	113.00	113.00
July	119.49	111.65	100.96	131.10	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	114.85	113.00	113.00	113.00
Aug.	119.49	110.22	105.74	131.10	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	114.85	113.00	113.00	113.00
Sept.	119.49	105.59	116.33	131.10	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	116.14	113.00	113.00	113.00
Oct.	119.49	100.96	120.41	131.10	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	120.00	113.00	113.00	113.00
Nov.	119.49	100.96	120.41	131.10	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	120.00	113.00	113.00	113.00
Dec.	119.49	100.96	120.41	131.10	131.10	127.82	127.82	127.82	127.82	118.56	118.56	118.56	118.56	120.00	113.00	113.00	113.00
Aver.	119.16	116.55	107.50	139.67	131.10	138.57	127.82	127.82	127.82	118.56	118.66	118.56	116.71	114.90	113.00	113.00	113.00

# Finished Iron and Steel at Chicago

## Soft Steel Bars at Chicago, Cents a Pound

	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	1.91	2.00	1.99	1.71	1.68	1.70	1.80	1.85	1.90
Feb.....	1.95	2.01	1.95	1.72	1.65	1.70	1.80	1.85	1.90
March.....	1.98	2.05	1.95	1.70	1.68	1.70	1.80	1.85	1.90
April.....	2.00	2.05	1.91	1.75	1.70	1.70	1.84	1.85	1.90
May.....	2.00	2.05	1.85	1.70	1.70	1.70	1.95	1.85	1.90
June.....	2.00	2.05	1.83	1.70	1.70	1.70	1.95	1.85	1.90
July.....	2.00	2.05	1.75	1.70	1.70	1.70	1.87	1.85	2.00
Aug.....	2.00	2.05	1.75	1.70	1.70	1.69	1.85	1.85	2.00
Sept.....	2.00	2.05	1.71	1.70	1.70	1.65	1.85	1.85	2.00
Oct.....	2.00	2.03	1.70	1.70	1.70	1.80	1.85	1.90	2.10
Nov.....	2.00	2.00	1.70	1.70	1.70	1.80	1.85	1.90	2.10
Dec.....	2.00	2.00	1.70	1.60	1.70	1.80	1.85	1.90	2.10
Aver.....	1.99	2.03	1.88	1.70	1.69	1.78	1.86	1.86	1.97

## Structural Shapes at Chicago, Cents a Pound

	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	1.91	2.00	1.99	1.71	1.68	1.70	1.75	1.85	1.85
Feb.....	1.95	2.01	1.95	1.72	1.65	1.70	1.75	1.85	1.85
March.....	1.98	2.05	1.94	1.70	1.68	1.70	1.75	1.85	1.85
April.....	2.00	2.05	1.90	1.75	1.70	1.70	1.75	1.85	1.85
May.....	2.00	2.05	1.83	1.70	1.70	1.70	1.90	1.85	1.85
June.....	2.00	2.05	1.79	1.70	1.70	1.70	1.90	1.85	1.85
July.....	2.00	2.05	1.75	1.70	1.70	1.70	1.86	1.85	1.95
Aug.....	2.00	2.05	1.75	1.70	1.70	1.69	1.85	1.85	1.95
Sept.....	2.00	2.05	1.71	1.70	1.70	1.65	1.85	1.85	1.95
Oct.....	2.00	2.03	1.70	1.70	1.70	1.75	1.85	1.85	1.95
Nov.....	2.00	2.00	1.70	1.70	1.70	1.75	1.85	1.85	1.95
Dec.....	2.00	2.00	1.70	1.60	1.70	1.75	1.85	1.85	1.95
Aver.....	1.99	2.03	1.81	1.70	1.69	1.71	1.83	1.83	1.90

## Rail Steel Bars at Chicago District Mill, Cents a Pound

	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	1.80	1.90	1.88	1.60	1.50	1.50	1.70	1.75	1.75
Feb.....	1.80	1.95	1.80	1.60	1.50	1.50	1.70	1.75	1.75
March.....	1.80	1.95	1.85	1.60	1.50	1.50	1.70	1.75	1.75
April.....	1.83	1.95	1.81	1.60	1.50	1.50	1.74	1.75	1.75
May.....	1.85	1.95	1.80	1.60	1.50	1.50	1.85	1.75	1.75
June.....	1.86	1.95	1.75	1.60	1.50	1.50	1.86	1.75	1.75
July.....	1.85	1.95	1.75	1.60	1.50	1.50	1.79	1.75	1.85
Aug.....	1.85	1.95	1.65	1.60	1.50	1.51	1.75	1.75	1.85
Sept.....	1.85	1.95	1.65	1.60	1.50	1.55	1.75	1.75	1.85
Oct.....	1.95	1.95	1.65	1.54	1.50	1.70	1.75	1.75	1.95
Nov.....	1.95	1.94	1.64	1.50	1.50	1.70	1.75	1.75	1.95
Dec.....	1.95	1.90	1.60	1.50	1.50	1.70	1.75	1.75	1.95
Aver.....	1.88	1.94	1.74	1.58	1.50	1.58	1.76	1.75	1.82

## Common Bar Iron at Chicago, Cents a Pound

	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	1.90	2.00	1.98	1.71	1.63	1.60	1.60	1.80	1.80
Feb.....	1.93	2.00	1.95	1.73	1.70	1.60	1.60	1.80	1.80
March.....	2.00	2.04	1.95	1.70	1.70	1.60	1.60	1.80	1.80
April.....	2.00	2.05	1.92	1.74	1.70	1.60	1.60	1.80	1.80
May.....	2.00	2.05	1.90	1.70	1.66	1.60	1.69	1.80	1.80
June.....	2.00	2.05	1.90	1.70	1.65	1.60	1.85	1.80	1.80
July.....	2.00	2.05	1.90	1.70	1.65	1.60	1.84	1.80	1.80
Aug.....	2.00	2.05	1.75	1.70	1.62	1.60	1.80	1.80	1.80
Sept.....	2.00	2.05	1.74	1.70	1.60	1.60	1.80	1.80	1.80
Oct.....	2.00	2.04	1.70	1.70	1.60	1.60	1.80	1.80	1.80
Nov.....	2.00	2.00	1.70	1.70	1.60	1.60	1.80	1.80	1.80
Dec.....	2.00	2.00	1.70	1.60	1.60	1.60	1.80	1.80	1.80
Aver.....	1.99	2.03	1.84	1.70	1.65	1.60	1.76	1.80	1.80

## No. 24 Gage Hot-Rolled Annealed Sheets at Chicago District Mills, Cents a Pound

	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	3.03	3.00	2.85	2.45	2.35	2.12	2.35	2.50	2.50
Feb.....	3.05	3.00	2.80	2.45	2.25	2.00	2.35	2.50	2.50
March.....	3.05	3.10	2.80	2.41	2.29	2.10	2.35	2.50	2.50
April.....	3.01	3.10	2.70	2.35	2.30	2.10	2.45	2.50	2.50
May.....	2.87	3.10	2.70	2.35	2.30	2.14	2.75	2.50	2.50
June.....	2.83	3.10	2.70	2.35	2.30	2.20	2.75	2.50	2.50
July.....	2.80	3.10	2.69	2.50	2.30	2.35	2.57	2.50	2.60
Aug.....	2.80	3.05	2.55	2.50	2.30	2.35	2.50	2.50	2.60
Sept.....	2.80	3.00	2.52	2.50	2.26	2.35	2.50	2.50	2.60
Oct.....	2.86	3.00	2.53	2.50	2.28	2.35	2.50	2.50	2.70
Nov.....	2.90	2.88	2.45	2.50	2.20	2.35	2.50	2.50	2.70
Dec.....	2.93	2.80	2.45	2.45	2.20	2.35	2.50	2.50	2.90
Aver.....	2.91	3.02	2.65	2.44	2.28	2.23	2.51	2.50	2.59

## Galvanized Sheets at Chicago District Mill, Cents a Pound

	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	3.88	3.75	3.60	3.00	2.90	2.76	2.95	3.20	3.20
Feb.....	3.90	3.75	3.40	3.00	2.57	2.55	2.95	3.20	3.20
March.....	3.90	3.85	3.40	3.00	2.93	2.70	2.95	3.20	3.20
April.....	3.86	3.85	3.40	2.90	2.95	2.73	3.05	3.20	3.20
May.....	3.75	3.85	3.33	2.90	2.95	2.86	3.35	3.20	3.20
June.....	3.70	3.85	3.29	2.87	2.95	2.95	3.35	3.20	3.20
July.....	3.65	3.85	3.25	3.00	2.95	2.95	3.23	3.20	3.30
Aug.....	3.65	3.70	3.18	3.00	2.91	2.95	3.20	3.20	3.30
Sept.....	3.65	3.65	3.10	3.00	2.85	2.95	3.20	3.20	3.30
Oct.....	3.65	3.65	3.10	3.00	2.95	2.95	3.20	3.20	3.30
Nov.....	3.65	3.60	3.10	3.00	2.95	2.95	3.20	3.20	3.30
Dec.....	3.68	3.50	3.04	2.96	2.95	2.95	3.20	3.20	3.50
Aver.....	3.74	3.74	3.27	2.97	2.93	2.85	3.15	3.30	3.27

## Cast Iron Pipe, Net Ton At New York, 6-in., and Larger

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$66.30	\$63.30	\$47.30	\$54.90	\$61.60	\$54.60	\$50.60	\$48.60	\$37.25	\$39.60	\$36.10	\$37.90	\$30.20	\$35.30	\$43.00	\$45.00	\$45.20
Feb.....	70.30	63.30	47.30	56.50	61.60	54.60	50.60	48.60	37.25	39.35	38.60	37.90	29.70	35.30	43.00	45.00	45.20
March.....	71.30	63.30	47.68	57.75	61.60	53.00	50.60	47.20	37.25	38.60	38.75	37.90	28.40	35.30	43.00	45.00	45.20
April.....	73.90	63.30	48.80	58.50	61.60	52.60	50.60	47.35	36.25	37.40	39.50	35.40	28.20	35.30	43.00	45.00	45.20
May.....	76.30	62.05	49.60	58.50	61.60	50.85	50.60	45.80	37.60	35.85	39.90	34.15	28.20	35.30	43.00	45.00	45.20
June.....	76.30	54.30	50.80	61.35	61.60	50.60	50.60	44.42	37.60	35.10	39.90	33.70	28.20	38.30	44.00	45.15	45.20
July.....	76.30	52.30	53.50	62.30	60.60	50.60	50.60	42.75	37.60	33.20	39.30	32.90	28.73	38.30	45.00	45.20	45.90
Aug.....	76.53	46.05	54.10	62.62	59.60	50.60	50.60	39.65	36.60	33.60	38.90	32.90	31.10	38.30	45.00	45.20	45.90
Sept.....	77.22	46.30	54.50	63.60	56.60	50.60	49.85	37.25	35.60	33.60	38.90	32.90	31.30	38.30	45.00	45.20	45.90
Oct.....	77.22	47.30	54.50	63.60	56.35	50.60	49.60	36.50	35.60	34.60	38.90	32.90	33.30	38.00	45.00	45.20	45.90
Nov.....	77.22	47.30	54.50	63.60*	55.60	50.60	49.60	36.25	37.32	34.60	38.65	32.90	33.30	43.00	45.00	45.20	45.90
Dec.....	68.87	47.30	54.75	63.60*	55.20	50.60	49.10	37.00	39.40	34.60	37.90	32.50	34.30	43.00	45.00	45.20	47.90
Aver.....	73.98	54.68	51.44	60.67	59.40	51.05	50.25	42.61	37.11	35.84	38.78	34.60	30.41	37.81	44.08	45.11	45.71

\*Concession of \$2 to \$3 a ton from this price to consumers willing to accept winter delivery.

## At Chicago, 6-in. and Larger

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$67.55	\$64.10	\$42.50	\$51.80	\$56.20	\$48.70	\$49.20	\$44.32	\$35.00	\$43.33	\$42.20	\$43.00	\$40.40	\$40.00	\$44.00	\$47.00	\$48.40
Feb.....	71.30	64.10	41.60	53.20	56.20	49.95	49.20	43.70	35.83	44.45	44.95	44.00	40.40	40.90	44.00	47.00	48.10
March.....	72.80	64.10	42.10	54.20	56.20	47.60	49.20	44.20	35.70	44.70	45.20	43.20	38.00	41.40	44.00	47.00	48.00
April.....	74.80	64.10	42.85	57.20	56.20	46.70	49.20	43.95	36.20	44.20	45.20	43.00	36.40	41.40	44.00	47.36	48.40
May.....	76.80	60.10	44.60	60.20	55.20	47.07	49.20	43.20	37.80	44.20	45.15	43.00	36.40	41.40	44.00	48.40	48.40
June.....	76.80	48.85	45.47	60.20	54.70	48.20	48.90	42.70	40.20	45.20	45.00	42.20	36.40	42.90	45.50	48.40	48.40
July.....	76.80	52.85	46.10	60.20	54.80	47.70	47.95	41.58	40.80	45.20	45.00	42.00	34.40	43.40	47.00	48.40	48.40
Aug.....	78.18	43.20	46.40	60.20	53.45	49.20	48.30	37.40	42.20	45.20	44.75	42.00	35.20	43.40	47.00	48.40	48.40
Sept.....	82.10	42.60	47.45	59.95	51.80	49.20	47.68	34.58	42.20	45.20	43.60	42.00	38.40	43.40	47.00	48.40	48.40
Oct.....	83.10	42.60	51.20	57.40	49.70	49.20	47.20	34.20	43.00	43.70	44.00	41.60	38.40	43.00	47.00	48.40	48.40
Nov.....	83.10	42.90	51.20	55.45	48.20	50.20	46.70	34.50	45.20	43.70	44.00	40.50	38.40	43.20	47.00	48.40	48.40
Dec.....	68.60	43.10	51.20	55.20	47.60	50.20	46.70	35.08	43.10	43.70	43.60	40.20	38.40	44.00	47.00	48.40	50.00
Aver.....	76.00	58.72	46.08	57.10	53.35	48.66	48.38	39.95	39.77	44.39	44.39	42.33	37.60	43.37	45.63	47.80	48.47

# Monthly Average Prices of Non-Ferrous Metals from Daily Quotations in THE IRON AGE

## Electrolytic Copper at New York, Cents a Pound

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	19.27	12.95	13.55	14.52	12.46	14.73	13.84	12.99	13.85	16.59	17.75	9.79	7.12	4.75	7.92	8.75	9.00
Feb.....	19.02	12.84	12.92	15.34	12.73	14.49	14.00	12.69	13.82	17.74	17.75	9.71	6.07	4.75	7.75	8.75	9.00
March.....	18.50	12.19	12.68	16.84	13.52	14.06	13.86	13.08	13.90	21.25	17.75	9.88	5.76	5.00	7.75	8.75	9.00
April.....	19.19	12.49	12.61	16.81	13.21	13.30	13.69	12.81	14.13	19.69	15.67	9.48	5.54	5.39	8.16	8.75	9.14
May.....	19.05	12.79	13.13	15.54	12.76	13.34	13.60	12.65	14.19	17.75	12.76	8.67	5.25	6.68	8.25	8.75	9.25
June.....	19.00	12.88	13.62	14.74	12.35	13.41	13.64	12.37	14.50	17.75	12.09	8.05	5.11	7.75	8.75	8.63	9.25
July.....	19.00	12.46	13.71	14.39	12.39	13.95	13.91	12.51	14.50	17.75	11.02	7.67	5.04	8.63	8.75	7.75	9.35
Aug.....	19.00	11.70	13.74	13.87	13.26	14.48	14.19	13.00	14.50	17.75	10.65	7.26	5.15	8.75	8.75	7.92	9.50
Sept.....	18.70	12.01	13.75	13.36	12.97	14.42	14.05	12.93	14.70	17.75	10.39	6.98	5.95	8.75	8.75	8.52	9.50
Oct.....	16.56	12.67	13.66	12.88	12.96	14.29	13.88	12.98	15.16	17.75	9.60	6.75	5.72	7.97	8.75	8.94	9.54
Nov.....	13.63	13.07	13.62	12.76	13.59	14.36	13.69	13.34	15.75	17.75	10.17	6.54	5.07	7.91	8.75	9.00	10.16
Dec.....	13.63	13.55	14.00	12.88	14.23	13.82	13.31	13.79	15.84	17.75	10.29	6.60	4.78	7.87	8.75	9.00	10.73
Aver.....	17.96	12.63	13.42	14.47	13.04	14.05	13.80	12.93	14.57	18.11	12.99	8.11	5.55	7.08	8.41	8.63	9.45

## Spelter (Zinc) at New York, Cents a Pound

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	9.94	7.88	7.38	9.62	5.53	5.06	7.28	6.78	8.10	8.75	7.03	6.00	6.70	5.59	4.37	3.38	3.38	4.62	4.03	5.22
Feb.....	10.48	7.99	6.70	9.14	5.36	4.85	7.58	7.11	7.86	8.16	7.04	5.90	6.70	5.53	4.36	3.19	3.04	4.73	4.06	5.23
March.....	10.77	7.64	6.52	8.93	5.20	5.00	8.19	6.85	7.68	7.69	7.06	5.98	6.80	5.30	4.30	3.16	3.37	4.72	4.25	5.27
April.....	9.85	7.01	6.51	8.63	5.24	5.25	7.65	6.49	7.35	7.36	6.69	6.11	7.04	5.19	4.06	3.10	3.68	4.72	4.34	5.27
May.....	9.46	7.32	6.46	8.08	5.28	5.45	6.99	6.13	7.30	7.16	6.43	6.37	6.98	4.98	3.66	2.90	4.17	4.71	4.60	5.27
June.....	9.62	8.01	6.93	7.92	4.95	5.69	6.40	6.14	7.35	7.47	6.57	6.50	7.00	4.79	3.75	3.16	4.70	4.59	4.67	5.26
July.....	8.95	8.69	7.90	8.18	4.77	6.12	6.43	6.25	7.60	7.76	6.58	6.55	7.10	4.66	4.25	2.92	5.24	4.68	4.70	5.16
Aug.....	8.69	8.96	7.84	8.31	4.69	6.59	6.68	6.53	7.55	7.69	6.70	6.59	7.15	4.72	4.17	3.13	5.28	4.63	4.12	5.17
Sept.....	8.34	9.60	7.57	7.82	4.74	6.91	6.81	6.54	8.12	7.76	6.56	6.60	7.15	4.62	4.09	3.68	5.08	4.43	5.04	5.22
Oct.....	8.24	9.11	7.83	7.51	5.10	7.20	6.66	6.67	8.65	7.66	6.35	6.60	7.09	4.40	3.73	3.41	5.12	4.19	5.21	5.22
Nov.....	7.95	8.70	8.14	6.84	5.18	7.48	6.70	7.14	9.04	7.56	6.09	6.62	6.63	4.63	3.55	3.46	4.87	4.08	5.23	5.35
Dec.....	7.84	8.45	8.59	6.00	5.25	7.46	6.60	7.73	8.97	7.39	6.15	6.70	6.09	4.43	3.50	3.50	4.82	4.06	5.22	5.64
Aver.....	9.18	8.28	7.36	8.08	5.13	6.09	7.03	6.70	7.96	7.70	6.60	6.59	6.87	4.90	3.98	3.25	4.40	4.51	4.70	5.27

## Lead, at New York, Cents a Pound

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	7.69	6.87	5.56	8.67	5.00	4.70	7.85	8.31	10.26	9.25	7.59	6.50	6.65	6.25	4.80	3.75	3.00	4.00	3.69	4.50
Feb.....	9.13	7.04	5.05	8.89	4.54	4.70	8.14	9.01	9.38	9.08	7.40	6.34	6.85	6.24	4.55	3.72	3.00	4.00	3.53	4.51
March.....	9.47	7.24	5.23	9.21	4.08	4.71	8.47	9.23	8.90	8.46	7.57	6.00	7.41	5.66	4.53	3.15	3.15	4.00	3.58	4.60
April.....	9.43	6.95	5.03	8.95	4.33	5.13	8.19	8.19	8.01	7.91	7.10	6.10	7.19	5.58	4.42	3.00	3.27	4.18	3.69	4.60
May.....	11.00	6.88	5.05	8.55	4.99	5.51	7.39	7.27	8.08	7.75	6.60	6.13	7.00	5.51	3.82	3.00	3.65	4.14	3.96	4.60
June.....	11.68	7.55	5.34	8.48	4.66	5.73	7.14	7.08	8.35	8.08	6.42	6.30	7.00	5.41	3.92	2.99	4.17	3.98	4.02	4.60
July.....	10.72	8.04	5.65	8.67	4.40	5.75	6.28	7.15	8.33	8.60	6.33	6.22	6.80	5.25	4.40	2.73	4.46	3.77	4.12	4.60
Aug.....	10.72	8.05	5.77	8.98	4.40	5.88	6.74	8.02	9.52	8.96	6.69	6.25	6.75	5.49	4.40	3.24	4.50	3.75	4.25	4.60
Sept.....	8.84	8.05	6.12	8.11	4.60	6.20	7.06	8.09	9.60	8.80	6.30	6.45	6.88	5.50	4.40	3.47	4.50	3.68	4.41	4.60
Oct.....	6.77	8.05	6.45	7.24	4.70	6.67	6.84	8.31	9.62	8.40	6.25	6.50	6.87	5.17	3.97	3.05	4.32	3.65	4.51	4.63
Nov.....	6.44	8.05	6.76	6.33	4.70	7.20	6.87	8.96	9.84	8.00	6.27	6.39	6.29	5.10	3.94	3.04	4.29	3.57	4.50	5.11
Dec.....	6.48	6.71	7.03	4.80	4.70	7.28	7.61	9.61	9.36	7.87	6.52	6.49	6.25	5.10	3.80	3.00	4.14	3.60	4.50	5.55
Aver.....	9.03	7.46	5.76	8.07	4.58	5.79	7.39	8.27	9.10	8.39	6.75	6.31	6.83	5.59	4.25	3.18	3.87	3.86	4.06	4.71

## Straits, Tin, at New York, Cents a Pound

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	62.74	35.94	32.03	39.16	48.70	58.26	62.20	66.43	55.56	49.21	38.84	26.03	21.80	22.70	51.98	50.91	47.23
Feb.....	59.57	32.16	30.74	41.98	53.41	57.09	63.65	69.05	52.47	49.39	38.63	26.27	21.97	23.51	51.78	49.99	47.94
March.....	61.93	28.79	29.14	48.61	55.03	53.67	64.47	69.23	52.11	48.85	36.76	27.02	21.81	24.35	53.84	46.88	48.00
April.....	62.12	30.36	30.53	45.84	50.02	52.27	63.35	67.88	52.28	45.93	35.90	25.13	19.17	27.16	55.66	50.05	46.97
May.....	54.99	32.50	30.92	43.11	44.08	54.65	62.36	67.47	51.53	43.88	32.16	23.16	20.90	35.94	53.57	51.10	46.31
June.....	48.34	29.39	31.46	40.97	42.74	55.93	60.63	67.42	47.92	44.20	30.26	23.53	19.53	44.23	51.31	51.08	42.24
July.....	49.29	27.69	31.67	38.47	46.29	55.05	62.98	64.01	47.01	46.29	29.76	24.96	20.89	46.28	51.94	52.31	42.96
Aug.....	47.60	26.35	32.36	39.33	41.89	58.12	65.17	64.41	47.97	46.60	30.00	25.73	22.98	44.71	51.99	50.46	42.57
Sept.....	44.43	26.70	32.36	41.60	49.24	58.27	68.89	61.43	48.06	45.32	29.59	24.51	24.76	46.46	51.52	49.05	44.77
Oct.....	40.47	27.70	34.61	41.80	50.60	62.24	70.36	58.49	48.99	42.25	26.76	22.72	23.91	47.95	51.01	51.25	44.95
Nov.....	36.97	28.93	36.76	44.09	54.25	63.30	70.75	57.49	50.76	40.18	25.87	22.78	23.31	53.14	51.24	51.88	51.30
Dec.....	34.04	32.41	37.48	47.16	56.03	62.94	68.68	58.54	50.23	39.87	25.01	21.28	22.70	52.91	50.92	49.77	51.85
Aver.....	50.23	29.91	32.51	42.68	50.19	57.90	64.29	64.32	50.39	45.16	31.63	24.43	21.98	39.12	52.23	50.39	46.42

\*Average through Dec. 23

## Aluminum (No. 1 Virgin, 99 Per Cent Plus), at New York, Cents a Pound

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan. ....	32.00	22.86	17.74	22.75	27.61	27.00	27.00	26.37	23.90	23.90	23.90	20.50	19.50	19.00	19.75	21.00	21.00
Feb. ....	31.83	24.50	17.33	23.25	27.71	27.00	27.00	25.83	23.90	23.90	23.90	20.50	19.50	19.00	19.75	21.00	21.00
March. ....	31.50	23.44	17.52	24.95	27.57	27.00	27.00	25.55	23.90	23.90	22.90	20.00	19.00	19.00	20.00	21.00	21.00
April. ....	31.61	23.25	18.07	26.00	27.46	27.00	27.00	25.55	23.90	23.90	20.50	19.50	18.50	19.50	20.00	21.00	21.00
May. ....	31.95	23.06	17.92	26.24	26.43	27.00	27.00	25.55	23.90	23.90	20.50	19.50	18.00	19.50	20.50	21.00	21.00
June. ....	32.00	22.75	17.87	26.25	26.27	27.00	27.00	25.55	23.90	23.90	20.50	19.50	18.00	19.50	21.00	21.00	21.00
July. ....	32.00	22.62	17.87	26.25	26.37	27.00	27.00	25.55	23.90	23.90	20.50	19.50	18.00	19.50	21.00	21.00	21.00
Aug. ....	32.21	20.22	17.87	26.07	26.52	27.00	27.00	25.55	23.90	23.90	20.50	19.50	18.00	19.50	21.00	21.00	21.00
Sept. ....	31.44	19.02	18.26	25.50	27.24	27.00	27.00	25.55	23.90	23.90	20.50	19.50	18.00	19.50	21.00	21.00	21.00
Oct. ....	29.12	17.85	20.32	25.50	27.16	27.24	27.00	25.29	23.90	23.00	20.50	19.50	18.00	19.50	21.00	21.00	21.00
Nov. ....	27.80	17.50	20.87	25.80	27.00	28.00	27.00	24.30	23.90	23.90	20.50	19.50	18.00	19.50	21.00	21.00	21.00
Dec. ....	23.53	17.50	22.52	26.31	27.00	28.00	26.85	24.26	23.90	23.90	20.50	19.50	18.50	19.50	21.00	21.00	21.00
Aver. ....	30.61	21.21	18.68	25.41	27.05	27.19	26.99	25.41	23.90	23.90	21.27	19.71	18.18	19.38	20.53	21.00	21.00

# \*Monthly Average Scrap Prices Computed from

No. 1 Heavy Melting Steel  
(Average of Pittsburgh, Chicago and

	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Jan.....	\$13.95	\$17.85	\$19.75	\$11.40	\$16.19	\$10.51	\$18.12	\$11.85	\$15.84	\$16.90	\$12.50	\$11.77	\$14.02	\$10.29	\$10.27	\$16.46	\$21.73	\$29.93
Feb.....	15.06	18.32	19.82	12.31	15.79	15.52	17.50	13.54	14.92	16.42	13.15	11.46	13.06	11.39	10.39	16.10	21.35	29.92
March.....	16.00	19.31	20.02	13.17	15.99	14.50	17.62	12.58	13.27	16.10	13.43	11.71	13.10	11.10	10.78	17.28	23.60	29.98
April.....	16.63	19.94	20.20	13.19	15.98	14.98	17.48	12.20	13.20	15.69	12.63	12.44	13.39	10.83	10.61	17.42	26.63	28.47
May.....	16.78	20.50	19.81	11.46	14.50	14.93	17.55	12.08	14.33	14.54	12.07	12.85	12.30	10.60	10.79	16.47	27.63	28.79
June.....	16.63	21.10	19.00	10.65	13.47	14.84	17.79	12.67	15.23	14.23	12.06	12.94	11.60	10.57	10.78	15.25	27.21	28.87
July.....	16.41	21.35	18.33	10.29	13.97	14.92	17.27	13.27	15.25	13.67	12.21	12.82	11.42	10.50	11.65	15.19	36.00	29.00
Aug.....	16.35	20.75	17.29	10.79	14.52	15.78	16.57	13.73	16.06	13.43	12.50	13.19	11.46	10.42	13.00	15.35	31.30	29.00
Sept.....	15.72	21.00	15.62	11.13	15.32	17.11	16.21	14.15	16.93	13.50	11.94	13.73	11.35	10.30	13.79	15.67	31.50	29.00
Oct.....	17.50	21.03	13.98	12.00	15.85	17.28	15.72	14.85	17.46	13.44	11.27	14.90	11.00	9.71	13.62	16.90	26.60	29.00
Nov.....	17.60	20.75	12.12	13.85	16.75	18.07	13.48	15.56	17.17	13.30	11.02	14.69	10.39	9.13	14.63	20.40	27.83	28.50
Dec.....	17.66	20.63	10.48	15.52	16.79	18.88	12.00	16.32	17.17	12.75	11.52	14.00	9.97	9.50	16.20	24.13	28.87	25.00
Aver.....	16.36	20.22	17.20	12.16	15.43	16.11	16.44	13.54	15.58	14.50	12.19	13.04	11.92	10.58	12.21	17.22	29.19	28.76

## Scrap Prices at Pittsburgh, Gross Ton No. 1 Heavy Melting Steel

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$19.00	\$26.30	\$15.50	\$14.30	\$21.80	\$21.38	\$21.50	\$18.63	\$16.88	\$15.10	\$19.31	\$16.69	\$13.19	\$10.22	\$8.30	\$13.00	\$13.35	\$14.44
Feb.....	14.75	27.75	16.00	14.00	23.25	20.88	19.50	17.50	16.13	14.94	18.63	16.81	12.88	10.25	8.50	14.00	13.06	14.96
March.....	14.00	27.25	14.00	15.13	25.38	19.38	18.50	17.55	16.55	14.81	18.44	16.56	12.80	10.25	8.88	14.44	12.19	15.75
April.....	15.30	26.00	12.65	16.38	25.88	16.20	17.00	16.63	16.50	15.31	18.60	15.95	12.39	10.12	10.00	14.19	11.55	15.75
May.....	14.75	25.00	13.30	17.30	22.80	15.63	16.75	15.69	15.40	15.25	17.88	15.25	11.25	9.60	11.75	12.80	11.62	14.50
June.....	17.12	25.00	12.69	17.00	21.13	16.00	17.30	15.75	14.81	14.56	18.25	15.13	10.30	8.75	11.75	11.75	11.75	13.57
July.....	19.70	26.00	12.00	17.38	18.10	17.50	18.00	16.81	15.00	14.10	18.55	14.75	10.56	8.25	12.72	11.75	11.95	14.19
Aug.....	21.00	28.13	12.79	17.75	17.75	17.50	18.88	17.50	15.40	15.50	19.00	15.13	10.69	8.60	13.85	11.31	12.94	15.94
Sept.....	19.20	29.00	13.63	20.13	17.88	18.10	18.70	17.88	15.50	16.56	18.31	15.60	10.65	9.54	12.94	10.75	13.25	17.80
Oct.....	19.00	27.75	14.13	21.40	15.70	18.50	18.50	17.25	14.75	17.60	17.30	14.56	10.22	9.62	12.15	10.35	13.40	17.87
Nov.....	22.25	23.50	14.30	20.50	16.13	19.63	19.50	17.20	14.25	17.19	16.39	13.19	10.22	9.15	11.50	10.94	13.56	17.31
Dec.....	24.25	17.20	14.25	20.13	18.75	21.40	19.10	16.75	14.88	17.90	15.45	12.75	10.25	8.75	12.13	13.01	14.05	18.31
Aver.....	18.55	25.74	13.76	17.82	20.58	18.51	18.80	17.10	15.50	15.74	18.01	15.20	11.98	9.42	11.21	12.50	12.72	15.87

## Machine Shop Turnings

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$11.20	\$15.50	\$10.00	\$9.60	\$16.90	\$15.75	\$17.50	\$14.30	\$12.00	\$10.80	\$11.50	\$11.50	\$6.00	\$6.50	\$6.25	\$8.70	\$8.70	\$ 9.87
Feb.....	8.50	17.88	10.00	9.56	18.50	16.13	15.88	13.63	11.38	10.88	11.50	11.39	6.44	6.50	6.25	10.25	8.75	10.25
March.....	9.00	18.00	9.40	10.50	20.38	14.50	14.20	13.35	12.00	10.25	10.63	10.94	7.65	6.75	6.25	11.00	7.31	10.50
April.....	10.12	16.70	8.13	11.88	20.50	12.45	13.39	12.00	12.63	10.44	11.15	10.90	7.06	6.56	6.81	10.38	7.30	10.50
May.....	11.62	13.38	8.70	13.30	19.20	11.88	12.25	11.00	11.30	10.20	11.06	10.19	6.57	6.00	8.30	8.35	8.06	9.99
June.....	9.68	14.75	7.56	13.32	17.19	13.00	13.05	11.00	10.50	9.00	11.63	9.56	6.50	5.12	8.38	7.25	8.12	9.05
July.....	11.60	13.40	7.00	14.00	12.10	13.50	13.63	11.38	11.50	9.10	11.90	8.60	6.75	4.75	9.50	7.50	8.10	9.37
Aug.....	13.50	15.25	7.85	14.00	11.44	14.13	15.00	12.80	11.80	9.88	13.00	8.00	7.00	5.30	10.50	7.50	8.88	10.62
Sept.....	12.25	16.30	9.06	14.75	12.88	14.40	14.75	13.06	11.63	11.13	12.06	8.00	7.30	6.00	10.00	7.13	9.50	12.20
Oct.....	12.75	15.88	9.56	16.20	11.60	14.25	14.39	12.06	11.50	11.10	11.75	6.88	7.00	6.00	9.30	6.75	9.50	12.25
Nov.....	14.00	14.63	9.85	16.63	11.63	15.94	15.00	11.90	11.10	11.00	11.00	6.00	6.94	6.00	7.75	7.13	9.44	11.50
Dec.....	14.25	10.50	8.88	15.63	13.75	17.20	14.30	11.50	11.00	11.10	10.25	6.00	6.70	6.12	8.00	8.70	9.60	12.37
Aver.....	11.54	15.55	8.85	13.28	15.51	14.43	14.44	12.34	11.53	10.41	11.45	8.98	6.83	5.97	8.11	8.39	8.91	10.68

## Cast Iron Borings

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$15.00	\$18.70	\$13.00	\$10.90	\$18.40	\$16.94	\$17.50	\$14.88	\$12.50	\$11.30	\$12.88	\$11.25	\$7.50	\$6.50	\$5.50	\$7.50	\$6.35	\$ 8.50
Feb.....	10.37	20.25	12.00	11.06	19.50	16.88	15.88	14.13	12.13	11.00	12.50	11.56	7.50	6.50	5.50	7.88	6.75	8.75
March.....	9.75	19.50	11.45	11.94	21.13	15.38	14.10	13.30	12.50	10.50	12.25	11.00	7.70	6.70	5.50	8.50	6.37	10.50
April.....	10.62	18.60	9.38	13.38	21.88	13.00	13.39	12.50	12.38	11.00	12.45	10.55	7.50	6.56	5.88	8.50	6.00	10.50
May.....	10.60	17.38	8.70	14.10	20.20	12.75	12.50	11.75	11.10	10.90	12.00	10.39	7.63	6.10	7.30	8.10	6.00	10.12
June.....	11.19	16.75	8.38	14.63	17.88	14.00	13.05	11.90	10.60	10.39	12.25	9.88	6.75	5.12	7.88	7.00	6.25	10.00
July.....	13.20	18.00	7.63	16.00	15.20	13.80	13.63	12.38	10.63	10.00	12.40	8.90	7.25	4.50	9.25	7.00	6.30	10.00
Aug.....	15.25	19.63	8.30	15.70	13.88	14.75	15.00	12.75	11.00	10.75	12.75	8.50	7.56	5.30	9.95	7.00	6.63	10.62
Sept.....	15.38	20.20	9.00	17.00	15.63	14.90	14.75	12.94	11.00	12.13	12.25	8.65	7.20	6.00	8.88	6.75	7.00	12.30
Oct.....	17.90	19.00	10.13	18.60	13.50	15.00	14.39	12.50	11.00	12.50	12.25	8.00	7.25	6.00	8.20	5.50	8.00	12.50
Nov.....	17.50	17.38	10.40	17.55	12.75	15.13	15.00	12.90	11.00	12.13	11.63	7.75	6.94	6.00	7.75	5.25	8.00	12.25
Dec.....	17.75	14.00	9.25	17.50	14.88	16.70	14.90	12.13	11.13	12.00	10.75	7.40	6.70	5.50	7.50	5.40	8.00	12.87
Aver.....	13.71	18.28	9.88	14.89	17.07	14.94	14.51	12.34	11.57	11.22	12.20	9.49	7.29	5.89	7.42	7.03	6.80	10.74

## No. 1 Cast Cupola Scrap

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$24.20	\$32.00	\$25.00	\$16.30	\$23.30	\$21.00	\$19.63	\$17.50	\$16.00	\$14.50	\$16.00	\$14.00	\$12.00	\$9.50	\$8.60	\$11.40	\$12.50	\$14.00
Feb.....	18.75	34.00	22.75	16.00	24.75	21.38	20.13	17.00	15.56	14.50	15.00	14.00	12.00	9.50	8.50	12.25	13.37	14.00
March.....	18.00	34.00	21.20	15.94	26.75	20.25	18.60	17.00	15.80	14.50	15.13	14.00	12.00	9.20	8.50	13.50	12.50	14.80
April.....	19.00	33.00	18.00	16.88	27.75	18.50	17.75	16.50	16.00	14.50	14.39	14.00	12.00	9.00	8.75	13.50	12.00	15.00
May.....	17.20	32.00	18.00	18.50	26.30	17.88	17.50	16.50	15.70	14.50	15.50	14.00	10.75	8.90	9.90	12.80	12.63	15.00
June.....	18.50	32.00	16.63	18.75	24.13	17.25	17.10	15.90	15.13	14.25	15.50	14.00	10.00	8.50	10.00	12.00	13.00	14.60
July.....	20.40	40.20	16.00	19.00	21.10	17.80	17.00	15.75	15.00	14.25	15.50	13.00	10.00	8.57	10.63	12.00	13.00	14.50
Aug.....	23.50	41.25	16.20	19.00	21.38	18.00	17.50	16.80	15.00	14.50	15.50	13.00	10.50	9.00	11.50	11.75	13.44	15.50
Sept.....	23.50	42.00	16.88	22.13	21.75	18.00	17.40	16.50	15.00	14.94	15.50	13.00	10.10	9.50	11.50	11.50	14.00	15.90
Oct.....	23.80	39.75	17.50	24.00	19.50	18.00	17.39	16.00	14.75	15.40	15.50	12.88	9.50	9.50	11.50	11.00	14.00	16.00
Nov.....	27.25	34.25	17.10	23.13	18.63	18.13	18.00	16.30	14.35	15.00	15.13	12.13	9.50	9.10	11.00	11.19	14.00	16.00
Dec.....	28.75	27.25	16.13	22.38	20.00	19.10	17.70	16.00	14.38	14.80	14.50	12.00	9.50	9.00	11.00	12.25	14.00	16.50
Aver.....	21.90	35.14	18.45	19.33	22.96	18.77	17.98	16.48	15.22	14.64	15.34	13.33	10.65	9.13	10.12	12.09	13.23	15.15

# Weekly Quotations in THE IRON AGE

## Scrap Composite Price

Philadelphia Quotations, Gross Ton)

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$17.77	\$25.13	\$14.04	\$12.45	\$20.22	\$19.15	\$20.10	\$16.97	\$15.17	\$13.70	\$17.02	\$14.65	\$11.30	\$8.41	\$6.77	\$11.73	\$12.18	\$13.48
Feb.....	14.75	26.00	15.21	12.46	21.46	19.21	18.27	15.50	14.58	13.71	16.96	14.92	11.15	8.27	6.83	12.25	11.98	14.12
March.....	14.52	25.50	13.17	13.46	24.79	17.56	16.92	15.83	14.65	13.65	16.71	14.88	11.10	8.23	6.96	12.82	11.06	14.75
April.....	15.79	24.42	11.63	14.71	24.00	15.20	15.48	15.27	14.71	13.81	17.18	14.30	10.83	8.12	7.73	12.54	10.46	14.59
May.....	15.06	23.71	12.20	16.67	20.77	14.71	15.46	14.35	13.95	13.90	16.54	13.71	9.94	7.48	9.70	11.57	10.70	13.39
June.....	16.54	23.47	11.47	15.52	18.94	14.88	16.09	14.40	13.60	13.52	16.39	13.31	9.39	6.89	9.97	10.67	10.74	12.81
July.....	19.13	24.21	11.00	15.92	17.23	16.00	16.46	15.42	13.48	13.13	16.60	13.08	9.25	6.46	11.27	10.53	10.96	13.29
Aug.....	20.25	25.88	11.57	16.30	16.58	16.58	17.23	15.88	13.50	13.75	16.86	13.29	9.25	6.93	12.08	10.15	12.25	15.04
Sept.....	18.87	26.53	12.15	18.33	16.98	17.20	17.42	16.25	13.92	14.75	16.60	13.70	9.12	7.69	11.35	9.63	12.71	16.45
Oct.....	18.67	23.73	12.88	19.20	15.15	17.08	17.08	15.58	13.48	15.85	15.78	12.77	8.78	7.62	10.56	9.54	12.67	16.63
Nov.....	20.50	20.00	12.73	18.02	15.13	18.17	17.63	15.25	13.18	15.97	14.15	11.28	8.61	7.45	9.94	10.04	12.50	16.31
Dec.....	22.77	15.92	12.29	17.94	17.37	20.08	17.37	15.08	13.48	15.97	14.15	11.28	8.61	6.92	10.50	11.43	13.33	16.94
Aver.....	17.89	23.71	12.61	15.53	19.05	17.16	17.12	15.48	14.00	14.29	16.30	13.45	9.79	7.54	9.47	11.07	11.83	14.32

## Eastern Pennsylvania Scrap Prices, Gross Ton

### No. 1 Heavy Melting Steel

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$17.20	\$24.75	\$14.50	\$11.00	\$19.70	\$18.20	\$18.50	\$17.00	\$15.39	\$13.50	\$16.39	\$14.50	\$10.50	\$7.00	\$6.75	\$11.70	\$11.40	\$12.62
Feb.....	14.75	25.62	14.25	12.00	20.75	18.38	17.63	15.88	14.63	13.50	16.39	14.63	10.50	7.00	6.75	11.75	11.62	13.25
March.....	14.19	25.20	13.00	12.78	25.25	16.75	15.90	16.00	14.50	13.50	16.13	14.88	10.50	7.00	6.75	11.88	10.50	13.75
April.....	15.50	24.12	11.25	14.00	23.63	15.30	14.63	16.00	14.50	13.50	17.00	13.95	10.31	7.50	7.19	11.69	10.00	13.69
May.....	15.00	23.37	11.80	14.75	19.80	14.75	14.63	15.25	14.10	13.50	16.39	13.39	9.69	6.00	8.90	10.95	10.44	12.81
June.....	16.12	22.60	11.25	15.00	17.88	15.00	15.10	14.70	14.00	13.39	16.00	12.75	9.10	6.00	9.25	10.50	10.50	12.00
July.....	18.90	22.62	11.00	15.00	16.60	15.40	15.63	14.63	13.39	13.00	16.50	12.50	8.44	6.00	10.68	10.30	10.55	12.31
Aug.....	19.37	25.00	11.40	15.20	16.00	16.75	16.38	16.20	13.70	13.00	16.50	12.63	8.69	6.30	11.95	9.94	11.44	14.00
Sept.....	18.62	25.62	11.50	16.88	16.75	17.10	17.20	16.88	14.00	14.75	16.39	13.00	8.50	7.25	11.25	9.63	12.38	15.40
Oct.....	19.10	22.75	12.06	17.80	15.40	16.63	16.75	16.50	14.00	16.00	15.70	12.38	8.13	7.25	10.20	9.53	12.10	15.75
Nov.....	20.62	19.00	11.88	16.25	15.25	17.75	17.38	15.50	13.50	15.50	15.00	11.75	8.00	7.25	9.75	9.94	12.13	15.12
Dec.....	22.50	15.25	11.50	16.38	16.75	20.10	17.50	15.50	13.50	15.40	14.50	11.10	7.75	6.75	10.44	10.75	12.50	15.50
Aver.....	17.66	22.99	12.12	14.80	18.65	16.84	16.44	15.84	14.13	14.05	16.07	13.12	9.18	6.77	9.16	10.71	11.80	13.85

### No. 1 Machinery Cast

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$23.50	\$36.00	\$23.25	\$16.50	\$23.20	\$20.70	\$20.13	\$18.39	\$17.00	\$16.00	\$16.31	\$15.00	\$12.00	\$10.00	\$8.00	\$12.00	\$10.90	\$13.00
Feb.....	23.00	40.00	23.00	16.50	24.25	20.25	18.88	17.75	17.00	16.00	16.50	15.00	11.90	10.00	8.00	12.00	11.00	13.00
March.....	21.25	39.20	19.40	17.13	28.25	18.63	18.00	17.50	17.00	16.00	16.50	15.00	11.50	9.90	8.00	12.75	11.00	14.00
April.....	22.00	38.00	18.00	17.25	26.25	17.70	17.25	17.50	17.00	16.00	16.50	14.85	11.50	9.75	8.50	12.88	11.00	13.87
May.....	21.50	37.75	18.00	18.40	24.30	17.00	17.00	17.25	16.80	16.00	16.50	14.00	11.50	8.12	10.25	12.10	11.00	13.50
June.....	22.00	37.00	17.38	19.00	22.25	17.50	17.50	17.00	16.00	16.00	16.00	13.50	11.20	8.00	10.25	12.00	11.00	13.50
July.....	22.10	37.50	16.50	17.50	20.40	17.50	17.63	17.00	16.00	15.50	16.50	13.00	11.00	6.50	11.81	11.60	11.00	14.12
Aug.....	24.75	39.00	17.00	18.60	20.38	17.88	18.00	17.70	16.00	15.50	16.50	13.00	11.00	8.20	12.50	11.50	11.12	15.19
Sept.....	25.00	39.25	17.00	21.50	21.38	18.00	18.00	19.00	16.38	16.25	16.88	13.00	11.00	9.25	12.50	11.50	11.50	16.30
Oct.....	25.20	38.75	17.13	22.60	19.50	17.50	18.00	17.39	16.50	17.10	16.00	13.00	11.00	9.50	11.50	11.10	12.10	16.50
Nov.....	27.62	33.80	17.50	21.00	19.25	17.88	18.00	17.30	16.13	16.39	15.88	12.00	11.00	9.31	11.25	10.50	12.50	16.50
Dec.....	30.75	24.50	16.63	20.25	20.25	19.50	18.13	17.00	16.00	16.25	15.00	12.00	10.10	8.00	11.81	10.50	12.90	16.75
Aver.....	24.08	36.73	18.49	18.85	22.47	18.34	18.04	17.48	16.48	16.08	16.28	13.61	11.23	8.88	10.36	11.70	11.42	14.69

### No. 1 Railroad Wrought

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$24.20	\$33.50	\$20.00	\$14.50	\$22.10	\$20.90	\$20.88	\$18.39	\$17.00	\$15.25	\$15.50	\$15.00	\$13.13	\$9.00	\$7.50	\$11.00	\$11.00	\$12.50
Feb.....	21.50	36.00	19.75	14.63	24.75	21.50	20.13	17.75	17.00	15.06	16.00	15.00	12.00	8.50	7.50	11.00	10.87	13.00
March.....	20.25	35.90	17.20	15.38	27.50	19.00	18.90	17.20	17.00	14.60	16.00	15.00	12.00	8.50	7.50	11.00	10.63	13.00
April.....	21.60	35.00	17.00	15.88	27.00	18.10	17.75	17.50	16.50	14.50	16.00	15.00	11.25	9.00	7.62	11.50	10.40	14.25
May.....	21.00	33.50	15.20	16.90	24.20	16.63	17.50	17.25	16.50	14.50	16.00	15.00	11.00	7.19	10.75	12.00	10.00	14.62
June.....	21.50	33.00	14.38	17.00	22.50	16.50	18.10	16.60	16.00	13.75	16.00	15.00	10.20	7.00	10.75	12.00	10.00	14.50
July.....	24.40	33.00	13.50	17.13	18.80	17.70	17.63	16.50	15.75	13.50	16.00	15.00	10.00	7.00	11.06	11.20	10.00	14.50
Aug.....	26.50	33.00	14.00	18.00	18.00	18.63	17.50	17.80	15.50	13.50	16.00	15.00	10.00	7.00	12.00	11.00	10.37	14.50
Sept.....	26.50	33.25	15.00	20.88	18.50	19.00	17.70	17.88	15.50	14.50	16.00	15.00	10.00	7.50	12.00	11.00	12.00	15.10
Oct.....	26.90	29.25	15.88	22.20	17.50	18.00	18.13	17.00	15.50	15.00	16.00	14.75	10.00	7.50	11.20	11.00	12.00	15.87
Nov.....	28.37	25.00	16.00	19.00	17.38	18.38	18.50	17.00	15.30	16.00	15.88	13.75	10.00	7.50	11.00	11.00	12.00	16.00
Dec.....	30.25	20.00	14.63	19.25	18.50	20.40	18.50	17.00	15.25	16.00	15.40	13.50	9.50	7.50	11.00	11.00	12.00	16.00
Aver.....	24.41	31.70	16.04	17.56	21.39	18.73	18.44	17.32	16.07	14.73	15.90	14.76	10.75	8.60	9.99	11.22	10.94	14.48

### Cast Iron Carwheels

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.	\$24.60	\$36.00	\$25.00	\$16.50	\$22.30	\$20.10	\$19.50	\$18.13	\$16.38	\$15.50	\$16.50	\$15.00	\$13.75	\$10.75	\$8.00	\$11.90	\$11.50	\$13.75
Feb.	23.00	40.63	24.00	15.00	24.75	20.38	18.38	17.50	16.00	15.50	16.50	15.00	13.50	10.00	8.00	12.50	12.25	14.50
March	23.00	42.40	18.50	15.94	26.50	18.75	18.50	17.50	16.00	15.50	16.50	15.00	13.40	9.70	8.00	12.88	11.87	14.50
April	23.10	40.00	18.00	15.88	26.50	17.50	17.75	17.50	16.00	15.50	16.50	15.00	12.63	10.00	8.75	13.00	11.00	14.37
May	21.00	40.00	16.50	24.20	17.00	17.00	17.00	17.25	16.00	15.50	16.39	14.88	12.25	8.94	9.75	12.50	11.00	13.62
June	22.00	38.00	18.00	17.13	22.75	17.00	17.00	17.00	15.38	15.50	16.00	14.50	12.00	8.25	10.25	11.38	11.00	13.50
July	23.20	38.50	16.50	17.50	20.40	17.30	17.25	17.00	15.00	15.50	16.39	14.50	12.00	7.00	12.00	11.00	11.00	13.87
Aug.	24.50	40.60	16.40	18.10	20.25	17.75	18.50	17.40	15.30	15.50	16.50	14.63	12.00	8.40	12.75	11.00	11.13	15.25
Sept.	24.50	42.75	17.00	21.75	21.00	18.00	18.50	17.50	15.50	15.88	16.50	15.00	12.00	9.50	12.00	11.00	11.50	16.30
Oct.	24.50	40.50	17.00	22.50	19.60	17.50	18.50	17.13	15.50	16.50	16.50	15.00	12.00	9.75	11.85	10.65	12.30	16.50
Nov.	27.75	36.40	17.20	20.50	17.75	17.88	18.50	16.60	15.50	16.50	15.75	14.38	12.00	9.31	10.75	10.37	12.50	16.50
Dec.	30.50	26.00	16.63	20.00	19.50	19.20	18.50	16.50	15.50	16.50	15.50	14.00	11.50	8.50	11.00	11.30	12.90	16.75
Aver.	24.30	38.48	18.42	18.13	22.18	18.80	18.16	17.22	15.87	15.78	16.29	14.74	12.42	9.17	10.26	11.62	11.66	14.96

## \*Scrap Prices at Chicago

### No. 1 Heavy Melting Steel, Gross Ton

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$17.40	\$24.50	\$15.13	\$11.45	\$10.15	\$17.69	\$19.44	\$15.12	\$13.25	\$12.50	\$15.39	\$12.75	\$10.27	\$7.50	\$5.25	\$10.50	\$11.80	\$13.37
Feb.....	15.06	25.00	15.13	11.38	20.33	17.88	17.69	13.88	13.00	12.69	15.88	13.31	10.06	7.25	5.25	11.00	11.25	14.19
March.....	15.63	24.25	12.50	12.38	23.50	16.66	16.45	13.95	12.90	12.63	15.66	13.19	10.00	7.25	5.25	12.13	10.50	14.75
April.....	16.41	23.75	11.00	13.75	22.50	14.10	14.81	13.19	13.13	12.63	15.95	13.00	9.81	7.14	6.00	11.75	9.85	14.34
May.....	15.62	23.00	11.50	14.95	19.70	13.75	15.00	12.13	12.35	12.95	15.39	12.50	8.88	6.45	8.45	11.05	10.06	12.87
June.....	16.69	22.95	10.81	14.56	17.88	13.63	15.75	12.45	12.00	12.63	14.94	12.06	8.75	5.69	8.91	9.75	9.97	12.85
July.....	19.40	24.13	10.00	15.25	17.05	14.90	15.60	14.19	12.06	12.30	14.75	12.00	8.75	4.88	10.42	9.55	10.35	13.37
Aug.....	20.88	25.35	10.60	15.95	16.00	15.50	16.44	14.00	12.30	12.75	15.06	12.13	8.38	5.75	10.46	9.19	12.38	15.19
Sept.....	19.10	24.81	11.31	18.13	16.31	16.40	16.35	14.00	12.25	12.94	15.13	12.50	8.20	6.25	9.84	8.50	12.50	16.15
Oct.....	18.25	21.50	12.44	18.40	14.15	16.13	16.00	13.00	11.69	13.95	14.30	11.38	8.00	6.00	9.47	8.75	12.50	16.25
Nov.....	20.88	18.45	12.25	17.31	14.00	17.13	16.00	13.00	11.50	14.50	13.15	10.13	8.00	5.93	8.60	9.25	13.00	16.50
Dec.....	21.80	16.20	11.13	17.25	16.06	18.95	15.75	13.00	12.06	14.55	12.50	10.00	7.80	5.25	8.94	10.50	13.25	17.00
Aver.....	18.09	22.82	11.98	15.06	18.05	16.05	16.27	13.49	12.39	13.09	14.84	12.03	8.91	6.88	8.07	10.16	11.45	14.74

### Steel Reolling Rails, Gross Ton

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$22.10	\$34.25	\$15.63	\$12.10	\$20.40	\$18.88	\$21.75	\$17.50	\$16.38	\$14.90	\$17.00	\$14.63	\$12.50	\$10.50	\$7.50	\$11.30	\$12.60	\$14.12
Feb.....	16.44	34.38	15.50	12.00	21.75	20.13	19.25	16.63	15.94	15.00	17.50	15.00	12.00	10.50	7.50	11.81	12.50	15.19
March.....	16.38	32.30	13.30	13.31	24.63	19.13	17.86	16.50	15.60	14.44	17.50	15.00	12.00	9.85	7.50	12.62	11.88	15.50
April.....	17.55	32.13	12.63	14.50	23.75	16.30	16.00	16.13	16.00	13.81	17.50	15.00	11.75	9.00	7.88	12.50	11.30	15.19
May.....	17.75	31.75	13.40	15.70	21.70	15.00	16.88	15.19	15.20	14.40	17.50	14.81	10.69	8.30	9.30	11.90	11.00	14.31
June.....	18.75	32.65	12.94	15.25	19.25	14.81	17.85	15.45	14.75	14.81	17.50	14.63	8.40	7.31	9.63	10.50	10.62	14.00
July.....	25.15	35.00	12.25	16.13	18.00	15.50	17.44	17.19	14.88	14.75	17.50	14.50	10.39	6.63	11.32	10.35	11.30	14.37
Aug.....	29.50	38.00	12.45	16.90	17.50	16.19	19.00	17.10	15.30	15.13	17.75	14.50	10.13	6.75	12.00	10.00	13.12	15.69
Sept.....	26.80	38.13	13.13	19.38	17.38	17.30	19.25	17.39	15.19	15.88	17.81	14.40	10.00	7.19	11.38	10.00	13.50	16.50
Oct.....	27.19	33.44	14.00	20.30	15.80	17.06	18.88	16.63	14.88	16.50	17.20	13.88	10.00	8.00	10.88	10.00	13.50	17.00
Nov.....	31.25	22.90	13.80	18.38	15.06	18.19	19.44	16.50	14.50	16.63	15.50	12.50	10.25	8.00	9.90	10.06	13.75	17.00
Dec.....	31.90	16.90	12.63	17.75	17.00	20.36	19.10	16.19	14.63	16.60	14.60	12.50	10.50	7.50	10.00	10.95	13.90	17.25
Aver.....	23.40	31.90	13.47	15.98	19.35	17.40	18.56	16.53	15.27	15.84	17.07	14.28	10.72	8.29	9.57	11.00	12.41	15.51

### Cast Iron Borings, Gross Ton

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$12.54	\$16.11	\$10.92	\$6.38	\$15.57	\$13.58	\$15.56	\$13.39	\$10.06	\$10.40	\$12.50	\$9.56	\$5.06	\$3.38	\$3.00	\$6.30	\$6.80	\$6.00
Feb.....	8.75	16.39	11.76	6.93	16.59	15.55	14.63	12.06	10.13	10.13	12.00	10.13	4.75	4.25	3.19	6.56	7.00	6.75
March.....	10.15	15.74	8.40	8.05	18.91	14.38	13.85	11.75	10.20	9.63	10.63	9.56	4.75	4.20	3.25	7.44	5.94	7.50
April.....	10.47	15.96	7.28	9.24	17.92	11.40	10.94	10.94	10.44	9.31	10.40	9.25	4.50	3.75	3.88	7.25	5.20	7.00
May.....	9.31	14.43	6.61	10.98	16.24	10.00	10.00	9.75	10.00	9.25	10.19	8.81	3.75	3.25	5.00	6.45	5.00	6.12
June.....	9.33	13.38	5.60	11.63	14.43	10.06	10.70	9.95	9.56	9.00	9.88	8.00	3.75	2.63	5.25	5.00	5.00	6.00
July.....	12.71	14.15	5.32	12.67	13.66	10.45	11.13	11.19	9.94	9.05	7.90	7.90	3.75	2.00	6.25	4.90	5.30	6.12
Aug.....	14.28	15.06	5.38	12.88	12.04	10.69	12.75	11.45	10.50	9.31	10.19	7.75	3.94	3.05	6.50	5.00	6.37	7.62
Sept.....	13.55	14.65	5.60	14.43	12.19	11.80	13.15	11.19	10.75	9.75	10.50	7.35	4.10	3.88	6.25	4.88	6.00	9.00
Oct.....	11.63	12.88	6.44	14.90	10.42	11.56	12.75	8.88	10.13	10.75	10.00	5.75	4.00	3.88	5.88	4.50	6.00	9.25
Nov.....	12.88	11.93	6.83	14.56	10.08	12.63	13.19	9.20	9.60	11.69	9.25	4.13	4.00	3.65	5.15	4.81	6.25	9.50
Dec.....	14.17	10.98	6.09	14.56	12.04	14.36	13.50	9.50	10.19	11.85	9.15	4.90	3.60	3.06	5.50	6.00	6.10	9.50
Aver.....	11.65	14.30	7.19	11.48	14.17	12.21	12.68	10.77	10.13	10.01	10.37	7.76	4.16	3.41	4.93	5.75	6.91	7.53

### Cast Iron Carwheels, Gross Ton

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$25.90	\$36.13	\$21.00	\$15.30	\$26.70	\$20.50	\$21.38	\$18.00	\$15.31	\$13.90	\$14.13	\$13.81	\$11.00	\$8.19	\$7.55	\$10.70	\$11.90	\$13.19
Feb.....	22.75	38.06	20.63	15.00	27.25	21.00	19.38	17.13	15.13	14.00	14.50	14.69	10.50	7.50	7.88	11.44	12.00	13.12
March.....	21.50	36.20	15.90	16.50	28.38	21.00	17.10	17.00	15.00	13.88	14.50	14.69	10.10	6.95	7.00	12.00	10.89	14.00
April.....	21.50	37.50	14.06	18.63	27.75	16.70	16.00	16.39	15.00	13.50	14.50	14.45	9.50	7.00	8.06	11.75	10.50	14.00
May.....	21.25	37.50	14.70	18.50	24.10	16.25	16.06	15.25	14.05	13.45	14.50	13.88	9.13	6.40	9.10	11.15	10.50	13.75
June.....	22.00	35.90	13.31	18.25	21.88	15.63	17.30	15.30	13.50	13.06	14.39	13.55	10.00	5.69	9.50	9.75	10.50	13.50
July.....	23.95	35.75	12.75	19.25	20.60	16.40	17.12	16.39	13.75	12.80	14.00	13.50	10.00	5.50	10.00	9.55	10.85	13.62
Aug.....	26.25	38.35	12.95	20.60	19.50	17.13	17.50	15.90	14.50	12.75	14.00	13.50	9.75	6.30	10.50	9.50	12.75	15.00
Sept.....	24.90	37.69	14.19	23.75	17.95	18.20	17.70	15.25	14.25	13.31	14.00	13.50	9.50	7.00	10.25	9.50	12.75	16.00
Oct.....	24.88	36.06	16.50	25.10	17.90	17.63	17.38	14.50	13.56	13.85	14.00	13.13	9.30	7.00	9.88	9.50	12.75	16.50
Nov.....	28.63	31.95	16.60	24.63	17.88	18.63	18.31	14.50	13.25	14.25	13.88	12.13	8.75	7.00	9.20	10.00	13.00	16.50
Dec.....	31.10	24.40	15.75	24.00	19.75	20.70	18.30	14.50	13.44	14.10	13.60	11.75	8.50	7.00	9.50	11.00	13.25	17.50
Aver.....	24.55	35.46	15.70	19.96	22.88	18.31	17.79	15.84	14.23	13.57	14.17	13.55	9.67	6.79	9.04	10.49	11.80	14.72

### Railroad Malleable Scrap, Gross Ton

	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Jan.....	\$16.06	\$13.60	\$18.69	\$16.39	\$12.75	\$7.00	\$5.50	\$11.10	\$13.70	\$15.94
Feb.....	16.06	13.50	19.39	17.13	11.94	7.00	5.50	11.75	12.75	16.87
March.....	16.00	12.63	19.39	16.88	11.70	6.65	5.63	12.25	13.06	18.00
April.....	15.88	12.75	19.35	16.55	11.13	6.38	6.75	12.00	12.80	17.12
May.....	14.45	13.00	18.56	15.75	10.25	6.00	9.35	11.30	13.00	15.75
June.....	13.50	12.69	17.81	13.94	9.55	5.19	9.75	9.75	12.50	15.50
July.....	13.63	12.85	16.85	13.50	9.00	4.63	10.25	9.55	12.35	15.62
Aug.....	14.50	12.88	16.94	13.50	8.43	5.10	10.50	9.38	14.50	17.25
Sept.....	13.69	14.39	17.00	13.50	7.50	6.75	9.75	8.75	14.75	18.10
Oct.....	13.13	15.30	17.00	13.13	7.40	6.38	9.38	9.00	14.65	18.50
Nov.....	12.55	15.88	16.39	12.69	7.25	5.50	8.70	9.13	15.31	18.12
Dec.....	12.81	17.00	16.10	12.25	7.00	5.50	9.75	11.20	15.75	19.0

# Current Metal Working Activity Statistically Shown

These Data Are Assembled by The Iron Age from Recognized Sources and Are Changed Regularly as More Recent Figures Are Made Available.

	November, 1936	October, 1936	November, 1935	Eleven Months, 1935	Eleven Months, 1936
<b>Raw Materials:</b>					
Lake ore consumption (gross tons)*.....	4,269,049	4,384,809	3,025,694	27,760,943	40,087,983
Coke production (net tons)*.....	.....	4,307,849	3,217,175	31,720,422	.....
<b>Pig Iron:</b>					
Pig iron output—monthly (gross tons)*.....	2,947,365	2,991,887	2,065,913	18,901,349	27,503,760
Pig iron output—daily (gross tons)*.....	98,246	96,512	68,864	56,591	82,101
<b>Castings:</b>					
Malleable castings—production (net tons)*.....	.....	51,778	44,277	420,797	.....
Malleable castings—orders (net tons)*.....	.....	55,521	47,778	410,038	.....
Steel castings—production (net tons)*.....	.....	74,775	36,165	361,195	.....
Steel castings—orders (net tons)*.....	.....	59,431	32,714	359,618	.....
<b>Steel Ingots:</b>					
Steel ingot production—monthly (gross tons)*.....	4,337,412	4,545,001	3,150,409	30,344,580	42,487,717
Steel ingot production—daily (gross tons)*.....	173,496	168,333	121,170	106,100	148,558
Steel ingot production—per cent of capacity*.....	79.05	76.70	54.73	47.93	67.69
<b>Finished Steel:</b>					
Trackwork shipments (net tons)*.....	4,756	5,547	3,090	39,204	63,234
Steel rail orders (gross tons)*.....	123,875	119,237	81,721	445,020	927,940
Sheet steel sales (net tons)*.....	294,080	223,195	289,101	2,270,171	2,383,572
Sheet steel production (net tons)*.....	224,031	235,057	224,541	2,216,216	2,357,559
Fabricated shape orders (net tons)*.....	117,798	127,303	91,693	972,368	1,429,348
Fabricated shape shipments (net tons)*.....	128,306	152,999	94,746	1,019,002	1,413,352
Fabricated plate orders (net tons)*.....	.....	33,791	19,116	222,731	.....
Reinforcing bar awards (net tons)*.....	18,740	22,135	11,475	289,315	316,240
U. S. Steel Corp'n. shipments (tons)*.....	882,643	1,007,417	681,820	6,709,784	9,757,767
Ohio River steel shipments (net tons)*.....	127,425	145,065	88,338	864,508	1,057,871
<b>Fabricated Products:</b>					
Automobile production, U. S. and Canada*.....	394,890	229,989	*408,550	*3,701,594	4,097,725
Construction contracts, 37 Eastern States <sup>1</sup> .....	\$208,204,200	\$225,839,900	\$188,115,000	\$1,580,408,400	\$2,475,600,300
Steel barrel shipments (number)*.....	.....	924,797	634,396	6,331,077	.....
Steel furniture shipments (dollars)*.....	.....	\$1,776,784	\$1,591,286	\$13,965,584	.....
Steel boiler orders (sq. ft.)*.....	.....	968,473	464,431	5,560,423	.....
Locomotive orders (number)*.....	174	22	0	28	354
Freight car orders (number)*.....	1,550	1,310	25	8,128	40,208
Machine tool index*.....	147.1	136.5	98.6	†93.8	†134.0
Foundry equipment index*.....	200.4	174.4	100.4	†122.9	†178.6
<b>Foreign Trade:</b>					
Total iron and steel imports (gross tons)*.....	.....	64,509	56,637	45,461	.....
Imports of pig iron (gross tons)*.....	.....	7,264	15,550	114,648	.....
Imports of all rolled steel (gross tons)*.....	.....	29,730	17,089	193,851	.....
Total iron and steel exports (gross tons)*.....	.....	261,882	205,242	2,828,067	.....
Exports of all rolled steel (gross tons)*.....	.....	132,434	88,008	812,159	.....
Exports of finished steel (gross tons)*.....	.....	110,886	68,324	688,831	.....
Exports of scrap (gross tons)*.....	.....	119,568	104,961	1,902,429	.....
<b>British Production:</b>					
British pig iron production (gross tons)*.....	643,100	670,300	525,100	5,862,700	7,010,200
British steel ingot production (gross tons)*.....	1,001,300	1,060,500	903,300	9,030,900	10,679,800
<b>Non-Ferrous Metals:</b>					
Lead production (net tons)*.....	43,625	42,156	40,369	379,744	415,896
Lead shipments (net tons)*.....	50,153	59,210	43,035	391,123	461,169
Zinc production (net tons)*.....	45,742	46,297	37,469	390,949	477,221
Zinc shipments (net tons)*.....	57,107	54,035	48,172	423,658	593,452
Deliveries of tin (gross tons)*.....	5,345	6,005	4,035	53,750	77,075

†Three months' average. \*Revised.  
Source of figures: \*Lake Superior Iron Ore Association; <sup>b</sup>Bureau of Mines; <sup>c</sup>THE IRON AGE; <sup>d</sup>Bureau of the Census; <sup>e</sup>American Iron and Steel Institute; <sup>f</sup>National Association of Flat-Rolled Steel Manufacturers; <sup>g</sup>American Institute of Steel Construction; <sup>h</sup>United States Steel Corp.; <sup>i</sup>United States Engineer, Pittsburgh; <sup>j</sup>When preliminary, from Automobile Manufacturers Association—Final figures from Bureau of Census; <sup>k</sup>F. W. Dodge Corp.; <sup>l</sup>Railway Age; <sup>m</sup>National Machine Tool Builders Association; <sup>n</sup>Foundry Equipment Manufacturers Association; <sup>o</sup>Department of Commerce; <sup>p</sup>British Iron and Steel Federation; <sup>q</sup>American Bureau of Metal Statistics; <sup>r</sup>American Zinc Institute, Inc.; <sup>s</sup>New York Commodities Exchange.

## Pig Iron Production in December Rose 1.6 Per Cent Over November

PRODUCTION of coke pig iron in December totaled 3,095,145 gross tons, compared with 2,947,365 tons in November. The daily rate in December, at 99,843 tons, was 1.6 per cent above the 98,246 tons in November. There was a gain of six furnaces, 170 being in blast on Jan. 1, against 164 on Dec. 1. Production for the year totaled 30,598,905 tons, a gain of 45.5 per cent over the 21,007,802 tons in 1935.

Among the furnaces blown in during the month were: One Bethlehem (Bethlehem Steel Co.);

one Swede (Alan Wood Steel Co.); one Edgar Thomson, one Gary (Carnegie-Illinois Steel Corp.); one Perry (Pickands, Mather & Co.); one Weirton Steel Co. furnace; one Iroquois (Youngstown Sheet & Tube Co.) and one Colorado Fuel & Iron Co. furnace.

Furnaces blown out or banked include one Aliquippa unit of the Jones & Laughlin Steel Corp. and the Norton furnace of the American Rolling Mill Co.

Complete tabulations will be published next week.

## Great Western Buys Consolidated Steel

THE Great Western Steel Co., Chicago, specializing in sheet mill products for 19 years, has entered the Detroit area by acquiring the sheet business of the McLouth Steel Corp., known for many years as the Consolidated Steel Corp., and will continue under this name at a new location, 1645 Beard Avenue. This move was prompted by the desire of the McLouth Steel Corp. to confine itself to hot strip production. W. E. Thoresen is the new president of Consolidated Steel Corp.

## A.F.A. Publishes Two New Codes

THE American Foundrymen's Association has published two tentative codes of recommended practices developed by its industrial hygiene codes committee. Code 36-27 is prepared to aid in the standardization of the general type of instruments and technique employed in determining the volume and velocity of air flow in exhaust systems. It covers the application and testing technique for pilot tubes, inclined and vertical manometer gages, revolving vane type anemometers and swinging vane type direct reading velocity meters.

Code 36-28 describes recommended practices for the ventilation of all grinding, polishing, buffing, scratch brushing or abrasive cutting-off wheels, and grinding or polishing straps or belts, and is very similar to the new State of

Illinois Buffing and Polishing Equipment Sanitation Law which many of the A.F.A. Industrial Hygiene Codes Committee members helped to draft. A series of definitions is followed by sections on applications for hood and branch pipe requirements, design of exhaust systems, testing exhaust systems and hood and enclosure design and minimum air velocity required.

## Sees 1937 Increase In Steel Houses

MORE steel houses and other buildings will be erected in 1937 than have been built in the last five years, according to Bennett Chapple, vice-president of the American Rolling Mill Co., Middletown, Ohio.

He bases his prediction on the volume of materials that have been ordered for delivery by two companies with which Armeo is cooperating.

Steel Buildings, Inc., which erected its first permanent steel house in June, 1935, after produc-

ing several experimental structures, sold 200 buildings last year. Contracts for materials for 750 steel buildings have been placed by the company's president, David S. Betcone.

The Insulated Steel Construction Co., which has been producing prefabricated steel buildings for five years, showed an increase of nearly 300 per cent in 1936 compared with 1935, and expects an even larger increase in business in 1937, according to Harry Wilson, vice-president.

## O'Leary Sees Large Replacement Demands

"If history repeats, the decline since 1929 will be made up in greater expansion in the late 1930's and 40's than the United States has ever experienced," John W. O'Leary, president, Machinery and Allied Products Institute, declared recently in a speech at Birmingham.

"Those who contend that production levels of 1929 would never be reached again have little ground to stand on today. To reach that level now is commonplace and hardly worthy of mention in the business and financial pages of the press.

"The principal handicaps to business and industrial expansion are legislation and threats of legislation. The only sources of prosperity are the productive enterprises of our country through which all the people cooperate to create wealth in the form of goods and services."

The Pacific Coast Iron & Steel Co., Los Angeles, has been awarded a contract for nine radial gates for the Gila Valley canal on the Colorado River, near Yuma, Ariz., at a low bid of \$21,116.72. Award also was made to the company for 12 gates for the desilting works at Imperial dam on its bid of \$9,291.04. The Berkeley Steel Construction Co., Berkeley, Cal., was awarded a contract at \$19,862.48 for 14 gates for the by-pass and influent channels and desilting works of the dam.

Republic Steel Corp. has acquired the Mt. Hope coal mine, Brownsville, Pa., formerly owned and operated by the Brownsville Coal & Coke Co. The mine will be operated under the direction of E. P. Winning, manager of Republic's northern coal mines.

## ANNOUNCEMENT

Price quotations other than those to be found in the Comparison of Prices table on page 182 are omitted from this issue, but will be published in the issue of Jan. 14.

## THIS WEEK ON THE ASSEMBLY LINE

**... Labor difficulties force week's production down 1944 units to 79,538 units.**

o o o

**... United Automobile Workers press demands—135,000 General Motors workers involved, and five Chevrolet and one Buick assembly lines are now idle.**

o o o

**... Foreign glass to enter Detroit as domestic glass strikes continue to tie up production and deliveries.**

**D**ETROIT, Jan. 4.—Strike news in the automobile industry continues to make the front page in the nation's newspapers, as United Automobile Workers press demands on General Motors and tie up one plant after another. The threat of a possible tie-up of all of General Motors' 69 plants brought John L. Lewis into conference with Secretary Perkins in Washington last Saturday to see what could be done to head off such a development.

However, the way things stand now, by the end of the week approximately 135,000 out of 275,000 General Motors employees in all countries will be out of work because of cessation of body production. Five Chevrolet assembly lines were out of production on Monday, and Buick's assembly line likewise was forced down. However, the main plants of both divisions are still in operation, but it is considered only a matter of days before these main plants will close.

### Stop Orders Issued

Stop orders have been issued on all supplies, such as steel, rubber, fabricated parts and machinery. All advertising has also been stopped.

According to William S. Knudsen, there is enough glass available to last General Motors three weeks, including the present one, and enough other parts are available to last through the month. Libbey-Owens-Ford has cut all fires but probably has a bank of rough glass ahead on which to get started should settlement with the Flat Glass Workers' Union be effected.

After several weeks of deadlock, Ralph H. Lind, regional labor board director from Cleveland, has

stepped into the plate glass situation as a special mediator, and his outstanding success in this capacity holds promise of an early settlement. Libbey-Owens-Ford has an important Belgian subsidiary which controls plants in five countries, and these plants are now being drawn upon for badly needed supplies. A boatload of glass is expected to dock within a few days, and this additional supply may help sustain Chrysler operations. However, a shutdown of principal General Motors' plants is expected regardless of how the plate glass situation develops.

### Authority For Strike

Authority to call a general strike in all General Motors' plants was granted to a special board of strategy set up by the UAW at a meeting held in Flint on Sunday. The board appointed a negotiating committee which drew up demands on General Motors and included the following provisions: A national strike settlement conference; the abolition of piece work, adoption of hourly rates and 30-hr. work week, higher minimum wage rates, reinstatement of discharged employees, and adherence to seniority rights; recognition of the UAW; and regulation of the speed of production.

Mr. Knudsen has indicated that while he is available to national officers for conference at any time, local plant managers will not be permitted to negotiate unless all sit-down strikers are cleared from plants. An injunction restraining picketing both inside and outside of the plants has been ignored by Flint strikers.

Sit-down strikers are trespassers, according to a strict interpre-

tation of the law, but it is felt that if a case were ever brought to court, there would be no jury that would bring in a conviction. It is generally conceded that public sentiment is so strong today that it will protect the laborers, be they guilty or not. As one commentator has aptly put it, "the efficiency of a sit-down strike is a matter of psychology rather than of legality."

General Motors is in a vulnerable position so far as public relations are concerned. Every effort will be made to maintain peace and avoid overt acts that might lead to violence and bloodshed whether the law is considered as being on its side or not.

### Production Declines

Automobile production in the United States and Canada showed a mild decline to 79,538 passenger cars and trucks during the week, as compared with 81,482 units assembled the week before, according to Ward's Automotive Reports. Minor declines in General Motors output were balanced by equally slight gains in Chrysler volume. Approximately 478,000 units were assembled in December, but it is anybody's guess what January production will be owing to the labor situation.

## Tell Berna New Manager of N.M.T.B.A.

**C.** R. BURT, president of the National Machine Tool Builders' Association, has announced the appointment of Tell Berna of Cleveland, Ohio, as general manager of the association from Jan. 4.

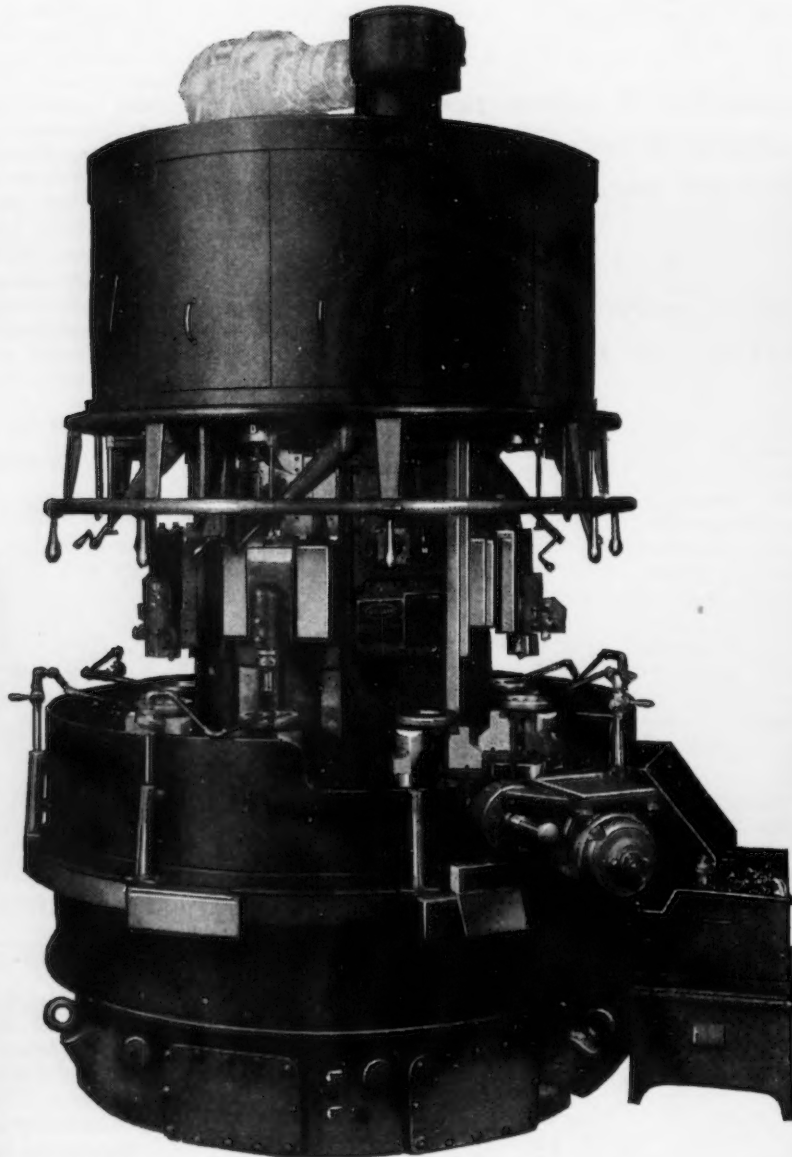
Mr. Berna is a graduate of Cornell University with a degree of mechanical engineer. He has been general sales manager of the National Acme Co. of Cleveland for the past six years, and prior thereto was successively sales manager for the Union Twist Drill Co. of Athol, Mass.; the G. A. Gray Co. of Cincinnati; and manager of the Cincinnati office of Cutler-Hammer, Inc. of Milwaukee.

Mrs. Frida F. Selbert continues as secretary of the association.

Mr. Berna succeeds Herman H. Lind who was general manager of the association from 1932 through 1936 and is now executive vice-president of the American Institute of Bolt, Nut and Rivet Manufacturers.

# Your 1937 Production - - ?!

If it's **VOLUME** you need or if it's added **Efficiency** and **Economy**—or maybe if it's these things combined **PLUS**—then, think of the **Mult-Au-Matic Method**.



Mult-Au-Matics are available in Types and Sizes to meet the requirements of work sizes, work volume, and also the requirements of quick return on the investment.

Multiple tooling at 5 or 7 stations provides an effective means of lowering manufacturing costs.

## MULT-AU-MATICS

Type	Size	Spindles
"D"	8"	6 and 8
"D"	12"	6 and 8
"D"	16"	6 and 8
"DA"	8"	6 and 8
"DA"	12"	6
"DA"	16"	6
"J"	7"	8
"J"	11"	8
"FH"	8"	Twin-Six Two at each Station

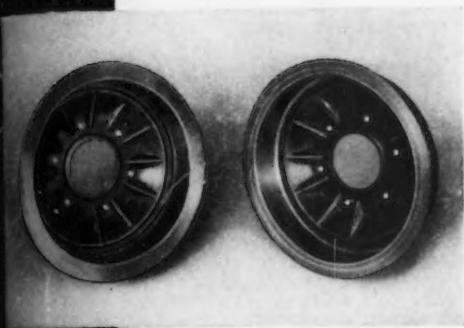
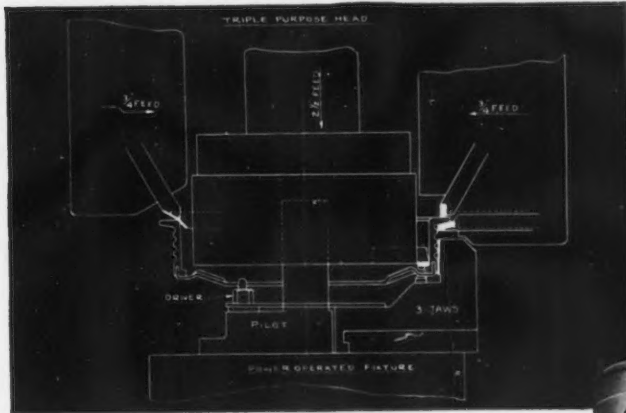
Send your requirements to Bullard Engineers and let them submit Estimates for your study and comparison.

# THE BULLARD COMPANY

BRIDGEPORT, CONNECTICUT

# Turning 1937 into Profits

Continuous Turning with the Contin-U-Matic Method—(different in principle from the Mult-Au-Matic)—provides 8 or 12 Spindles with each of the 8 or 12 stations rotating about a central column in fixed relation to its own spindle. Tooling is the same at all stations, and at the completion of the carrier cycle, each station produces finished work.

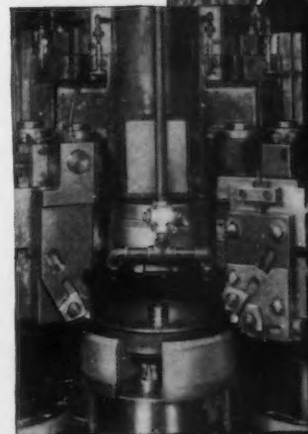
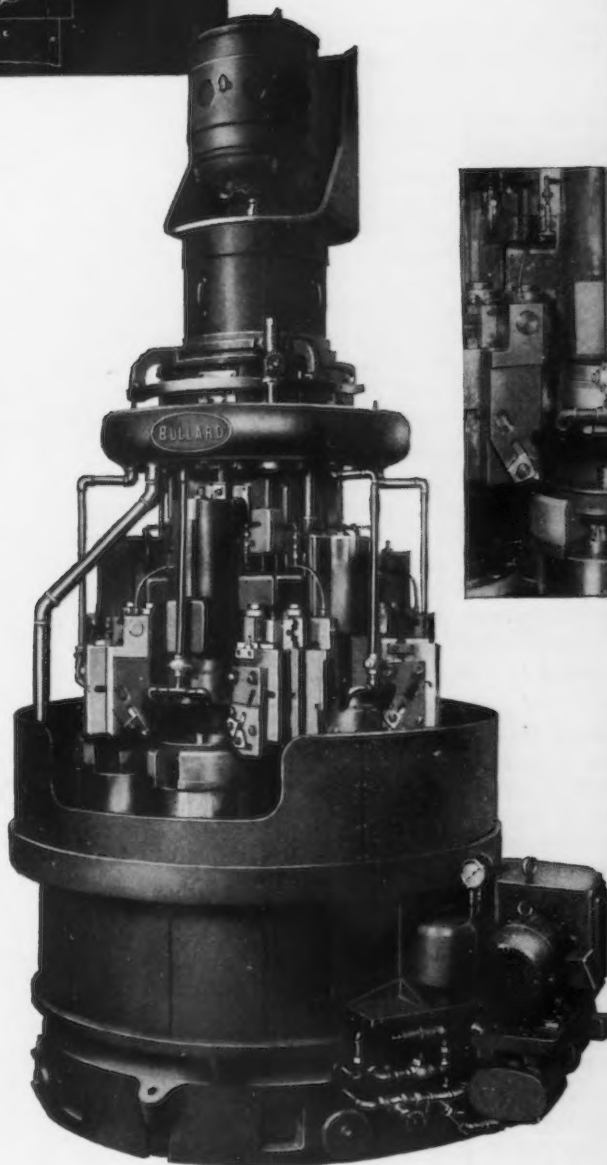


This continuous method of machining provides an extremely effective means of lowering manufacturing costs on large volume schedules.

Bullard Contin-U-Matics in every respect live up to rigid specifications for Accuracy, Long Useful Life, Efficiency, Economy, and Profitable Investment when advantageously located in your production lines.

## CONTIN-U-MATICS

Type	Size	Spindles
"D"	10"	6
"D"	14"	6
Hydraulic chucking on both sizes.		
2	10"	6
Power Operated Chucking.		
2	10"	12
Hydraulic Chucking		



# THE BULLARD COMPANY

BRIDGEPORT, CONNECTICUT

# A Comparison of Prices

Market Prices at Date, and One Week, One Month, and One Year Previous;  
Advances Over Past Week in Heavy Type, Declines in Italics

## Rails and Semi-finished Steel

Per Gross Ton:	Jan. 4, 1937	Dec. 28, 1936	Dec. 8, 1936	Jan. 7, 1936
Rails, heavy, at mill.....	\$39.00	\$39.00	\$39.00	\$36.37 1/2
Light rails, Pittsburgh.....	38.00	38.00	35.00	35.00
Rerolling billets, Pittsburgh	34.00	34.00	32.00	29.00
Sheet bars, Pittsburgh.....	34.00	34.00	32.00	30.00
Slabs, Pittsburgh.....	34.00	34.00	32.00	29.00
Forging billets, Pittsburgh...	40.00	40.00	39.00	35.00
Wire rods, Nos. 4 and 5, P'gh	43.00	43.00	43.00	40.00
	Cents	Cents	Cents	Cents
Skelp, grvd. steel, P'gh, lb...	1.80	1.80	1.80	1.80

## Finished Steel

Per Lb.:	Cents	Cents	Cents	Cents
Bars, Pittsburgh.....	2.20	2.20	2.05	1.85
Bars, Chicago.....	2.25	2.25	2.10	1.90
Bars, Cleveland.....	2.25	2.25	2.10	1.90
Bars, New York.....	2.55	2.55	2.40	2.20
Plates, Pittsburgh.....	2.05	2.05	1.90	1.80
Plates, Chicago.....	2.10	2.10	1.95	1.85
Plates, New York.....	2.34	2.34	2.19	2.09
Structural shapes, Pittsburgh	2.05	2.05	1.90	1.80
Structural shapes, Chicago...	2.10	2.10	1.95	1.85
Structural shapes, New York	2.31 1/4	2.31 1/4	2.16 1/4	2.06 1/4
Cold-finished bars, P'gh.....	2.55	2.55	2.35	2.10
Hot-rolled strips, Pittsburgh.	2.15	2.15	2.15	1.85
Cold-rolled strips, Pittsburgh	2.85	2.85	2.85	2.60
Hot-rolled annealed sheets, No. 24, Pittsburgh.....	2.80	2.80	2.80	2.40
Hot-rolled annealed sheets, No. 24, Gary.....	2.90	2.90	2.90	2.50
Sheets, galv., No. 24, P'gh..	3.40	3.40	3.40	3.10
Sheets, galv., No. 24, Gary..	3.50	3.50	3.50	3.20
Hot-rolled sheets, No. 10, Pittsburgh.....	2.15	2.15	2.15	1.85
Hot-rolled sheets, No. 10, Gary.....	2.25	2.25	2.25	1.95
Cold-rolled sheets, No. 20, Pittsburgh.....	3.25	3.25	3.25	2.95
Cold-rolled sheets, No. 20, Gary.....	3.35	3.35	3.35	3.05
Wire nails, Pittsburgh.....	2.25	2.25	2.25	2.40
Wire nails, Chicago dist. mill	2.30	2.30	2.30	2.45
Plain wire, Pittsburgh.....	2.60	2.60	2.60	2.30
Plain wire, Chicago dist. mill	2.65	2.65	2.65	2.35
Barbed wire, galv., P'gh.....	2.75	2.75	2.75	2.80
Barbed wire, galv., Chicago dist. mill.....	2.80	2.80	2.80	2.85
Tin plate, 100-lb. box, P'gh*.	\$4.85	\$4.85	\$5.25	\$5.25

\*Practically the equivalent of previous quotation owing to new method of quoting effective Jan. 1, 1937.

On export business there are frequent variations from the above prices. Also in domestic business, there is at times a range of prices on various products, as shown in our detailed price tables.

## Pig Iron

Per Gross Ton:	Jan. 4, 1937	Dec. 28, 1936	Dec. 8, 1936	Jan. 7, 1936
No. 2 fdy., Philadelphia....	\$22.76	\$22.3132	\$22.3132	\$21.3132
No. 2, Valley furnace.....	21.00	20.50	20.50	19.50
No. 2, Southern Cin'ti.....	20.60	20.44	20.44	20.2007
No. 2, Birmingham.....	17.38	16.88	16.88	15.50
No. 2, foundry, Chicago*....	21.00	20.50	20.50	19.50
Basic, del'd eastern Pa....	22.26	21.8132	21.8132	20.8132
Basic, Valley furnace.....	20.50	20.00	20.00	19.00
Malleable, Chicago*.....	21.00	20.50	20.50	19.50
Malleable, Valley.....	21.00	20.50	20.50	19.50
L. S. charcoal, Chicago.....	26.54	26.2528	26.2528	25.2528
Ferromanganese, seab'd, car- lots.....	80.00	80.00	80.00	75.00

†This quotation is subject to a deduction of 38c. a ton for phosphorus content of 0.70 per cent or higher.

\*The switching charge for delivery to foundries in the Chicago district is 60c. per ton.

## Scrap

Per Gross Ton:				
Heavy melting steel, P'gh...	\$19.25	\$19.25	\$17.75	\$14.25
Heavy melting steel, Phila...	16.75	16.25	15.25	12.50
Heavy melting steel, Ch'go...	17.75	17.75	16.50	13.25
Carwheels, Chicago.....	18.00	18.00	17.00	13.25
Carwheels, Philadelphia....	17.25	17.25	16.75	13.00
No. 1 cast, Pittsburgh.....	17.25	17.25	16.75	14.25
No. 1 cast, Philadelphia....	17.25	17.25	16.75	13.00
No. 1 cast, Ch'go (net ton)..	15.50	15.50	14.50	12.00
No. 1 RR. wrot., Phila.....	15.75	15.75	15.75	12.25
No. 1 RR. wrot., Ch'go (net)	16.50	16.50	14.25	11.00

## Coke, Connellsville

Per Net Ton at Oven:				
Furnace coke, prompt.....	\$4.00	\$4.00	\$3.85	\$3.65
Foundry coke, prompt.....	4.50	4.50	4.25	4.25

## Metals

Per Lb to Large Buyers:	Cents	Cents	Cents	Cents
Electrolytic copper, Conn...	12.00	11.62 1/2	10.50	9.25
Lake copper, New York.....	12.12 1/2	11.75	10.62 1/2	9.37 1/2
Tin (Straits), New York....	51.35	52.25	51.62 1/2	46.87 1/2
Zinc, East St. Louis.....	5.45	5.45	5.05	4.85
Zinc, New York.....	5.82 1/2	5.82 1/2	5.42 1/2	5.22 1/2
Lead, St. Louis.....	5.85	5.85	5.05	4.35
Lead, New York.....	6.00	6.00	5.20	4.50
Antimony (Asiatic), N. Y..	13.75	13.25	12.62 1/2	13.75

# The Iron Age Composite Prices

## Finished Steel

Jan. 4, 1937	2.330c. a Lb.
One week ago	2.274c.
One month ago	2.197c.
One year ago	2.130c.

Based on steel bars, beams, tank plates, wire, rails, black pipe, sheets and hot-rolled strips. These products represent 85 per cent of the United States output.

	HIGH	LOW
1936.....	2.330c., Dec. 28;	2.084c., Mar. 10
1935.....	2.130c., Oct. 1;	2.124c., Jan. 8
1934.....	2.199c., April 24;	2.008c., Jan. 2
1933.....	2.015c., Oct. 3;	1.867c., April 18
1932.....	1.977c., Oct. 4;	1.926c., Feb. 2
1931.....	2.037c., Jan. 13;	1.945c., Dec. 29
1930.....	2.273c., Jan. 7;	2.018c., Dec. 9
1929.....	2.317c., April 2;	2.273c., Oct. 29
1928.....	2.286c., Dec. 11;	2.217c., July 17
1927.....	2.402c., Jan. 4;	2.212c., Nov. 1

## Pig Iron

\$20.25 a Gross Ton
19.73
19.73
18.84

Based on average of basic iron at Valley furnace and foundry irons at Chicago, Philadelphia, Buffalo, Valley and Southern iron at Cincinnati.

HIGH	LOW
\$19.73, Nov. 24;	\$18.73, Aug. 11
18.84, Nov. 5;	17.83, May 14
17.90, May 1;	16.90, Jan. 27
16.90, Dec. 5;	13.56, Jan. 3
14.81, Jan. 5;	13.56, Dec. 6
15.90, Jan. 6;	14.79, Dec. 15
18.21, Jan. 7;	15.90, Dec. 16
18.71, May 14;	18.21, Dec. 17
18.59, Nov. 27;	17.04, July 24
19.71, Jan. 4;	17.54, Nov. 1

## Steel Scrap

\$17.92 a Gross Ton
17.75
16.17
13.33

Based on No. 1 heavy melting steel quotations at Pittsburgh, Philadelphia and Chicago.

HIGH	LOW
\$17.75, Dec. 21;	\$12.67, June 9
13.42, Dec. 10;	10.33, April 23
13.00, Mar. 13;	9.50, Sept. 25
12.25, Aug. 8;	6.75, Jan. 3
8.50, Jan. 12;	6.43, July 5
11.33, Jan. 6;	8.50, Dec. 29
15.00, Feb. 18;	11.25, Dec. 9
17.58, Jan. 29;	14.08, Dec. 3
16.50, Dec. 31;	13.03, July 2
15.25, Jan. 11;	13.08, Nov. 22



## ...SUMMARY OF THE WEEK...

*... Steel production only slightly affected by automotive strikes.*

• • •

*... Hold-up orders giving mills an opportunity to satisfy other users.*

• • •

*... Heavy bookings in final week of 1936; pig iron up 50c.; scrap strong.*

THE strikes in automotive plants have thus far had a minor effect on steel mill production, which stands at 79½ per cent, unchanged from last week.

The General Motors Corp. has issued hold-up orders to steel mills and parts suppliers, but these are giving the steel industry an opportunity to catch up on deliveries to miscellaneous consumers whose orders have been piling up in heavy volume during recent weeks.

Shortage of glass may affect automobile companies whose plants are otherwise free from labor troubles. A boatload of glass from Belgium is expected within a few days to relieve the situation at the Chrysler plants. All General Motors plants probably will be shut down by the end of the week unless mediation efforts now under way should bring an end to the strikes before that time.

THE Pittsburgh district has been least affected by the automotive situation, as steel for motor cars forms a smaller part of steel production in that area than elsewhere. Pittsburgh ingot output has, in fact, increased one point up to 79 per cent of capacity and the Wheeling district is also up a point to 95 per cent. The Cleveland-Lorain district has gained two points to 79 per cent and the Chicago plants are averaging 77 per cent, only a half point below last week. The Youngstown area is the only one seriously affected, production having declined eight points to 73 per cent.

Although the automotive situation is causing the steel mills considerable difficulty because of

sudden rearrangement of rolling schedules, there is at the moment no apprehension that operating rates on the average will be reduced materially.

The settlement of the strikes will undoubtedly be followed by renewed pressure from automotive plants for steel to make up for lost production.

ALL other major consuming outlets for steel continue to press forward. Railroad shops and car and locomotive builders are taking more steel, the agricultural equipment industry starts the new year most favorably, tin plate production continues at 95 per cent of capacity with no signs of abatement, and there was heavy coverage at the year-end in structural shapes and plates for building projects. Steel mill bookings grew enormously in the last week of the old year, and some companies have had to go back to war years for like totals.

New railroad equipment orders have been added to the heavy 1936 business. The Chicago & North Western has ordered 1000 freight cars and 23 passenger coaches and will buy eight locomotives; the Duluth, Missabe & Northern has bought 1000 ore cars; the Western Pacific has ordered 11 locomotives and the Delaware, Lackawanna & Western five; the Illinois Central will buy 3200 freight cars and the Nashville, Chattanooga & St. Louis 500.

PIG iron price advances of 50c. a ton went into effect as of Jan. 1 at all major producing points, raising THE IRON AGE composite price to \$20.25. The scrap composite has also advanced to \$17.92 because of a 50c. increase at Philadelphia. Elsewhere scrap markets are strong, reflecting a diminished supply of scrap because of automotive shutdowns. Pig iron sales have been stimulated by the recent price increase.

Production of coke pig iron in December totaled 3,095,145 gross tons compared with 2,947,365 tons in November. The daily rate in December, at 99,843 tons, was 1.6 per cent above the 98,246 tons in November. There was a gain of six furnaces, 170 having been in blast on Jan. 1 against 164 on Dec. 1. The year's output was 30,598,905 tons, a gain of 45.5 per cent over the 21,007,802 tons produced in 1935.

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# WASHINGTON

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## **... Seventy-fifth Congress opens session— John L. Lewis in fiery tirade against employers.**

WASHINGTON, Jan. 5.—The Seventy-fifth Congress convened today and organized. Tomorrow it will go through the formality of counting the electoral votes by which President Roosevelt, with only Maine and Vermont dissenting, was kept in office, and then listen to the President read his annual message on the "state of the union."

His message delivered, a rather clear picture will be given the country of certain policies of the New Deal in its second term. Because of its powerful dominance it will easily be able to have those policies written into statutes. It seems a safe prediction that much domestic legislation and some international legislation, particularly as relating to neutrality and tariff agreements, will be asked. Therefore Congress has almost certainly settled down for a long session, despite the fact that the present is known as a "short" session. Government and "emergency" laws will originate in the White House.

The President is deeply concerned over what it is claimed has been a breakdown of maximum hour and minimum wage standards and the increase in child labor since invalidation in May, 1935, of the NRA. With some heat he commented on the situation at his press conference last Tuesday and declared that something must be done by the Federal Government about it. His remarks clearly were directed chiefly at conditions in the minor industries, though it is reported that, despite weak wages and shortened hours in major industries, reports on the latter also are being studied. It is believed that the President had in mind such industries as the garment industry. He is convinced that it cannot be solved by the States, but rather calls for Federal action.

The White House frowns on references to legislation to reenact an NRA, either as a means of regimentation for industry generally or as applicable to individual industries. There seems to be a de-

sire to make the very term "NRA" taboo. Nevertheless, in Congress at least, there are strong groups which want new NRA legislation, more as to individual industries rather than by way of attempting modified Blue Eagle legislation. The Guffey bill and the Ellenbogen bill are in fact proposed NRA's, the former to govern wages and hours in the coal and the latter to regulate wages and hours in the textile industry. The President has not gone on record with regard to either measure. He has nevertheless definitely said that obviously something has to be done in the way of coal legislation. And John L. Lewis insists upon it.

The character of coal legislation may shape itself as the result of conferences Lewis and other United Mine Workers officials are holding with coal operators preliminary to negotiating new wage agreements, effective April 1. On the outcome of these negotiations may be determined the matter of a strike or no strike. And if a strike were called it is said efforts would be made to pull out miner in captive mines owned by the steel and other interests, and perhaps an effort to pull out steel workers. This is said to be one objective of Lewis' CIO drive. The idea is said to be to build up unionization in steel and face both steel and coal simultaneously with strike threats if CIO's terms are not met.

### **John L. Lewis's Tirade**

SELDOM equaled in fiery character, the slashing nation-wide broadcast delivered New Year's eve by John L. Lewis was designed to be a highly impressive report on the state of the union—Lewis's Committee for Industrial Organization. It was timed to the opening of the Seventy-fifth Congress. It was a dictum to Congress, to the White House and to the Supreme Court. Support the CIO in its ambitious drive to set up labor control on its own terms, Lewis demanded, in effect, and if industry—steel, automotive, coal and industry in general—does not submit

then industry will be paralyzed by strikes. The heavy roll of unemployment will be piled up by the addition of millions. The blame, according to Lewis would lie with industry.

The gage of battle thrown down to industry with bellicose declamation, whether or not it be taken at face value, was only secondary to the purpose of the CIO's "New Year's" sizzling message. It served notice to Federal agencies that they must provide the CIO with the weapons for its unbridled industrial warfare.

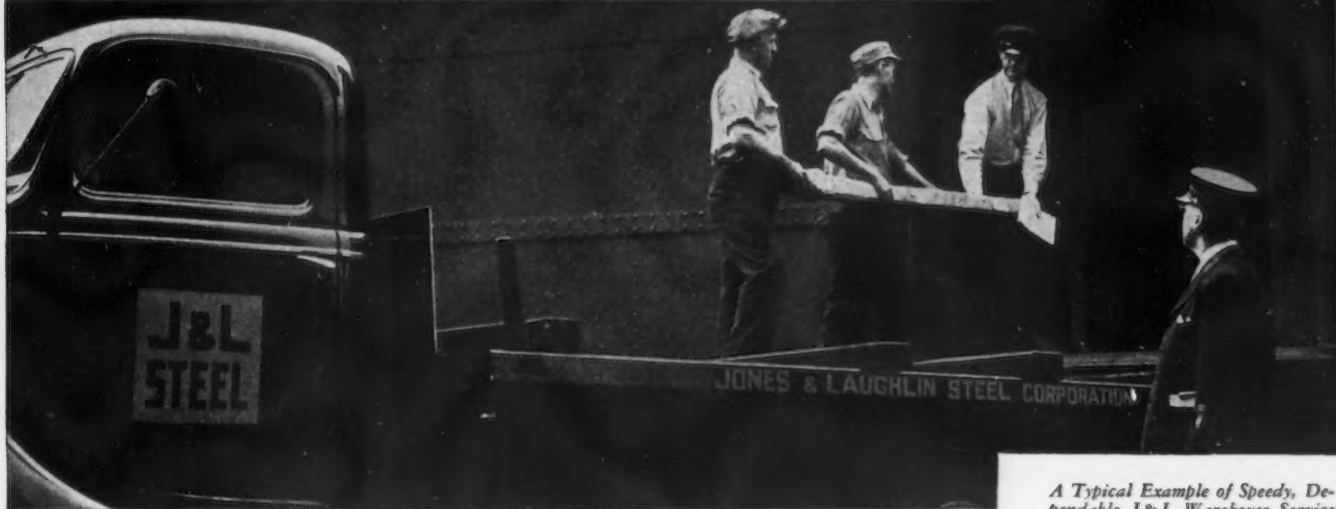
Lewis through both the CIO and Labor's Non-Partisan League campaigned vigorously for the reelection of President Roosevelt. As if demanding payment for services rendered, Lewis called attention to and placed his own construction on the President's labor speech at Madison Square Garden in New York shortly before election day which, Lewis said, represents President Roosevelt's "concept of industrial democracy." Lewis's subject was "Industrial Democracy," and he sententiously fitted the President's "concept" of that democracy to his own and by rather pointed implication told the White House to perform its obligations. The Supreme Court was the object of unrestrained condemnation and contemptuous reference. It was told that it "exalts property above human values," that it has usurped its powers and was otherwise slurred with a torrent of flubdub by one who would set himself up as prosecutor, judge and jury. The supposition is that Lewis was "warning" the Supreme Court against invalidating the National Labor Relations Act or otherwise inviting his displeasure. Lewis then shed a tear for Congress and solaced it with assurance of labor's support.

"Either by constitutional amendment or statutory enactment, the right of Congress to legislate for the welfare of the people and the perpetuity of the Republic must be assured," said Lewis, "Labor will support the elected representatives of the Republic in any attempt to restore to the Federal Congress the legislative powers of which it has gradually been stripped by the judicial encroachment and arbitrary decrees of the Supreme Court."

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from Your **J & L** *Warehouse*



When you need steel quickly, for emergency or regular needs, it will pay you to call your J & L Warehouse. Your order will be filled promptly and accurately, and rushed to you—by express if necessary—to save time and money for you and to help you avoid costly delays in your production schedule.

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every J & L Warehouse is equipped with modern and complete facilities for cutting, forming, welding and fabricating steel, to give you the steel you want in ready-for-use form—to help you save time, cut costs and increase your profits.

Steel users everywhere find that the fast complete service offered by J & L Warehouses saves time and money for them. You, too, will profit by ordering the steel you need from your nearest J & L Warehouse. Send for free J & L Warehouse Stock List.

**JONES & LAUGHLIN STEEL CORPORATION**  
AMERICAN IRON AND STEEL WORKS  
PITTSBURGH, PENNSYLVANIA

*A Typical Example of Speedy, Dependable J & L Warehouse Service*

A broken shaft—men idle—production halted. A call to the J & L Warehouse. No freight service available, but immediate delivery necessary. The shafting went that day by passenger train.



For Every Need . . . the  
Right Quality of Steel  
in a Full Range of Sizes



## J & L WAREHOUSES

CHICAGO  
Virginia 1600

CINCINNATI  
Main 2324

DETROIT  
Plaza 0470

NEW ORLEANS  
Franklin 1131

PITTSBURGH  
Hemlock 1000

NEW YORK (Long Island City)—Ironsides 6-8700 . . . Operated by National Bridge Works Division of Jones & Laughlin Steel Service, Inc.  
LOUISVILLE—Magnolia 2140 . . . Stock of Bars for Concrete Reinforcement and Bar Fabricating Yard  
MEMPHIS—6-4836 . . . Distributing Warehouse for Pipe, Sheets, Spikes and Wire Products. Reinforcing Bar Warehouse and Fabricating Shop

# FABRICATED STEEL

## NORTH ATLANTIC STATES

Turner, Me., 270 tons, State bridge, to Pittsburgh-Des Moines Steel Co., Pittsburgh.

Concord, N. H., 150 tons, State bridge, to Bethlehem Steel Co.

Orford, N. H., 900 tons, bridge, to American Bridge Co.

Boston, 750 tons, court house substructure, to New England Structural Co., Everett, Mass.

Springfield, Mass., 350 tons, city bridge, to Phoenix Bridge Co., Phoenixville, Pa.

Lynn, Mass., 265 tons, garage addition for Eastern Massachusetts Street Railway Co., to New England Structural Co.

New York, 745 tons, track stringers for Manhattan bridge, to Bethlehem Fabricators, Inc., Bethlehem, Pa.

New York, 200 tons, factory building, Eighth Avenue and 23rd Street, to Dreier Structural Steel Co.

Brooklyn, 110 tons, Greenpoint Savings Bank, to Weatherly Steel Co., Weatherly, Pa.

Buffalo, 375 tons, Bliss & Laughlin building addition, to Lackawanna Steel Construction Co., Buffalo.

Buffalo, 185 tons, Iroquois Beverage Co. storage building, to Buffalo Structural Steel Co., Buffalo.

Depew, N. Y., 160 tons, Erie Railroad bridge, to Jones & Laughlin Steel Corp.

Depew, N. Y., 370 tons, transit road grade crossing elimination, to Bethlehem Steel Co.

Jamaica, N. Y., 235 tons, grandstand extension for Metropolitan Jockey Club, to Berkshire Iron Works.

Belleville, N. J., 260 tons, Wallace & Tiernan building, to Joseph T. Ryerson & Son, Inc.

Colonial, N. J., 510 tons, highway bridge, to American Bridge Co.

## SOUTH AND SOUTHWEST

State of Texas, 1340 tons, Santa Fe bridge requirements in 1937, to American Bridge Co.

Brownsville, Tex., 145 tons, Dodds & Wedegartner wharf and transfer shed, to Mosher Steel Co., Dallas, Tex.

Fort Defiance, Ariz., 200 tons, Government Indian Hospital, to Capitol Steel & Iron Co., Oklahoma City, Okla.

## CENTRAL STATES

Lafayette, Ind., 1300 tons, Purdue University field house, to American Bridge Co.

Hammond, Ind., 540 tons, civic auditorium, to New City Iron Works.

Delaware County, Ind., 1900 tons, bridges, to Indiana Bridge Co., Muncie, Ind.

Detroit, 220 tons, storage warehouse for Grand Trunk Western Railroad, to Whitehead & Kales Co.

Plymouth, Mich., 900 tons, factory and boiler house, Burroughs Adding Machine Co., to Whitehead & Kales Co., Detroit.

Chicago, 250 tons, felt and paper mill building, U. S. Gypsum Co., to Worden-Allen Co., Milwaukee.

Lincoln, Neb., 100 tons, subway, to St. Joseph Structural Steel Co., St. Joseph, Mo.

Bayard, Neb., 205 tons, I-beam span, to Lincoln Steel Works, Lincoln, Neb.

## WESTERN STATES

Los Angeles, 6700 tons, transmission towers, Southern California Edison Co., to Bethlehem Steel Co.

## NEW STRUCTURAL STEEL PROJECTS

### NORTH ATLANTIC STATES

Hoboken, N. J., 800 tons, building, Alco Gravure, Inc.

New York, 375 tons, stores and apartment building, Springler-Van Buren Estates.

New York, 1000 tons, track covering, West 121st to West 124th Streets, for New York Central Railroad.

Poughkeepsie, N. Y., 200 tons, post office.

Sidney and Bainbridge, N. Y., 450 tons, State grade crossing eliminations.

Union, N. Y., 225 tons, Erie Railroad bridge.

Castanea, Pa., 250 tons, highway bridge, route 18013.

Lincoln, Pa., 270 tons, highway bridge, route 31013.

Johnstown, Pa., 410 tons, Hickory Street bridge.

Reading, Pa., 300 tons, factory addition, Wilson Products, Inc.

Washington, approximately 3000 tons.

## PIPE LINES

Carbide & Carbon Chemicals, South Charleston, W. Va., plans two 4-in. welded steel pipe lines across back channel of Kanawha River to point on Blaine Island, for natural gas transmission. Main offices of company are in New York.

G. C. Holmes, Jamestown, N. Y., and M. E. Ashworth, Smethport, Pa., are at head of a project to build a welded steel pipe line from gas field in western Pennsylvania to Jamestown and vicinity, for natural gas transmission to latter points, where distributing systems will be installed. Terminal plant for distribution is planned at Jamestown.

Board of County Supervisors, Los Angeles, has low bid from Western Pipe & Steel Co., Los Angeles, for welded steel pipe and appurtenances for outlet works at San Gabriel Dam No. 1, at \$169,283.95, comprising 123-in., 96-in., 75-in., 60-in., 51-in., and 30-in. sections, varying from 1½ to ¾-in. plate.

Bureau of Reclamation, Denver, closes bids Jan. 15 for two 72-in. welded plate steel outlet pipes for installation in outlet works at Bartlett Dam, Salt River Project, Ariz. (Specifications 865-D.)

St. Maries, Idaho, has low bid from E. K. Ferguson Co., Spanish Fork, Utah, for steel pipe line for trunk water system at \$102,040.30, comprising 44,840 ft. of 10 and 12-in., 8-gage steel pipe, and 2500 ft. of 10-in., 3/16-in. plate steel pipe; Pacific Waterworks Supply Co., Seattle, tendered low bid for valves and meters. Fund of \$116,363 has been secured through Federal aid. Arthur Tiggebeck, Sandpoint, Idaho, is consulting engineer.

Port Allen, La., plans steel pipe line system for municipal natural gas dis-

tribution. Surveys and estimates of cost are being made. Financing will be arranged through Federal aid. L. J. Voorhies, Plaquemine, La., is consulting engineer.

## THE SOUTH

Miami, Fla., 2100 tons, beams, etc., for Overseas Road and Toll Bridge district.

## CENTRAL STATES

Columbus, Ohio, 200 tons, mill building, Timken Roller Bearing Co.

Detroit, 900 tons, incinerator buildings, Wayne County Commissioners.

Jackson, Mich., 600 tons, buildings for Goodyear Tire & Rubber Co.

## FABRICATED PLATES

### AWARDS

Milton, Vt., 200 tons, Public Electric Light Co. units, to Bethlehem Steel Co.

Leetsdale, Pa., 460 tons, five sand barges for Pfaff & Smith, to Nashville Bridge Co., Nashville, Tenn.

Georgetown, S. C., 1500 tons, Southern Kraft Corp. pipe line to American Rolling Mill Co., Middletown, Ohio.

Cleveland, 360 tons, five tanks for Gulf Refining Co., to Chicago Bridge & Iron Works, Chicago.

Omaha, Neb., 205 tons, 42-in. pipe line, to National Tube Co.

## NEW PROJECTS

Wheeling, W. Va., 2500 tons, 25 coal barges for Wheeling Steel Corp.

## SHEET PILING

### AWARDS

Rehoboth Bay, Del., 1450 tons, jetties on Broadkill River, to Jones & Laughlin Steel Corp.

Buffalo, 500 tons, sewage treatment plant, Bird Island, to Jones & Laughlin Steel Corp.

## RAILROAD BUYING

Chicago & Illinois Midland is inquiring for two 0-8-0 type locomotives.

Norfolk & Southern has ordered 25 automobile cars from Magor Car Corp.

Duluth, Missabe & Northern has placed 1000 ore cars with Pullman-Standard Car Mfg. Co.

Western Pacific has ordered four 2-8-8-2 locomotives from Baldwin Locomotive Works and seven 2-6-6-4 locomotives from American Locomotive Co.

Chicago & North Western has ordered 500 automobile cars from Mount Vernon Car Mfg. Co., 500 hopper cars from Pressed Steel Car Co., and 23 main line coaches from Pullman-Standard Car Mfg. Co.

Illinois Central is in the market for 3200 freight cars.

Delaware, Lackawanna & Western has ordered five 4-6-4 passenger locomotives from American Locomotive Co.

Nashville, Chattanooga & St. Louis is inquiring for 500 box cars. Plans are under way to spend \$1,500,000 to air condition main-line passenger trains, lay new rails and improve motive power.

Gulf, Mobile & Northern has ordered one locomotive from American Locomotive Co.

# NON-FERROUS

... Non-ferrous metals featured by rise in copper price to 12c. basis.

NON-FERROUS metals were featured last week by a sudden rise in copper prices. The domestic quotation for electrolytic grade was lifted  $\frac{3}{4}$ c. on Dec. 31 to the basis of 12.00c. a lb., Connecticut Valley, against 11.62 $\frac{1}{2}$ c. previously. In making the advance, copper producers were influenced by renewed foreign inquiry coming into the market here which caused the export price equivalent to move up to 12.00c., European ports, just prior to the revision in domestic quotations. The former price continues today at from 11.95c. to 12.00c., and demand is active. Current inquiry from domestic users is in fair quantity, although sales are partially restricted due to limited offerings. Business over the week-end amounted to 5600 tons of new orders taken.

The price for pig lead at New York, since attaining a 6.00c. level, has remained stationary, but buyer interest has lasted, and no change in the situation is indicated at present. The leading producer continues to obtain a \$1 a ton premium on orders taken in the East. This source likewise reports that, with the opening of February books today, enough new inquiry has materialized to dispose of allotted intake by early afternoon. Inquiry in other directions appears slightly less pronounced. As for some months past, shipments continue strong, the estimated tonnage moved during December having been between 51,000 and 53,000 tons.

The zinc market has shown little change recently, with published quotations firm at the 5.45c., East St. Louis, level, but with occasional spot sales being transacted at a higher figure. As a result of a

## Tool Steel Volume Largest Since 1929

THE 1936 demand for increased production in all lines of manufacture has been reflected in the largest tool steel volume since 1929, according to L. Gerard Firth, president Firth-Sterling Steel Co., McKeesport, Pa.

The outlook for an even greater increase for this industry during 1937 is in evidence due to the rising production among manufacturers generally; the need for the replacement of a large percentage of obsolete machines; and the introduction of the new carbide tools. These tools, because of their high-speed cutting qualities, have been an influential factor in the demand for new machines designed to utilize more fully the increased speed of this metal-cutting material.

The Firth-Sterling Steel Co. will have in operation early in 1937 a new plant devoted entirely to the production of carbide and carbide tools. The added facilities of this

belief that consumers have overbought their needs, the market is being watched for possible speculative purchases, in instances where sales continue to be reported.

Little business has stirred in the tin market for quite some time. The New York spot Straits price has weakened further, and today is quotable at approximately 51.35c. a lb. The outlook for renewed activity is clouded by continuance of the shipping strike. London quotations this morning were standard spot £231 and futures £231 10s. The Eastern price was £234 7s. 6d. American deliveries of tin in December aggregated 6930 tons.

modern plant will aid the company in keeping abreast of the increased demand and will permit the employment of additional men in this department.

## Steel & Wire Takes Over Joliet Plant

TRANSFER of the Joliet, Ill., plant and property of the Carnegie-Illinois Steel Corp. to the American Steel & Wire Co., effective Jan. 1, was announced in Chicago by G. C. Kimball, executive vice-president of Carnegie-Illinois. Property transferred will include the splice bar mills, spike mills, merchant mills, and bolt and nut factory. The Carnegie-Illinois Steel Corp. will retain two blast furnaces and the coke plant.

## 68,341 Freight Cars Ordered in 1936

MORE freight cars were ordered in 1936 than in any year since 1930, according to year-end figures compiled by *Railway Age*, which show a total of 68,341 cars on the books for the year as compared with 77,097 cars in 1930. Locomotive orders also boomed, the 556 ordered in 1936 exceeding those placed on books in 1930 by a single locomotive, and reverting back, therefore, to 1929, when orders were placed for 1395 engines. Passenger car orders were small, amounting only to 317 cars. Even this number, however, is the greatest ordered since 1930, with the exception of 1934, when 388 cars were ordered.

The Week's Prices. Cents Per Pound for Early Delivery

	Dec. 29	Dec. 30	Dec. 31	Jan. 2	Jan. 4
Electrolytic copper, Conn.*	11.62 $\frac{1}{2}$	11.62 $\frac{1}{2}$	12.00	12.00	12.00
Lake copper, N. Y.	11.75	11.75	12.12 $\frac{1}{2}$	12.12 $\frac{1}{2}$	12.12 $\frac{1}{2}$
Straits tin, spot, New York	52.25	51.45	51.70	....	51.35
Zinc, East St. Louis	5.45	5.45	5.45	5.45	5.45
Zinc, New York†	5.82 $\frac{1}{2}$	5.82 $\frac{1}{2}$	5.82 $\frac{1}{2}$	5.82 $\frac{1}{2}$	5.82 $\frac{1}{2}$
Lead, St. Louis	5.85	5.85	5.85	5.85	5.85
Lead, New York	6.00	6.00	6.00	6.00	6.00

\* Delivered Connecticut Valley; price  $\frac{1}{4}$ c. lower delivered in New York.

† Includes emergency freight charge.

Aluminum, virgin 99 per cent plus 19.00c.-21.00c. a lb. delivered.  
Aluminum No. 12 remelt No. 2 standard, in carloads, 17.00c. a lb. delivered.  
Nickel, electrolytic, 35c. to 36c. a lb. base refinery, in lots of 2 tons or more.  
Antimony, Asiatic, 13.75c. a lb., New York.  
Quicksilver, \$88.50 to \$92.00 per flask of 76 lb.  
Brass ingots, commercial 85-5-5-5, 10.65c. a lb., delivered; in Middle West  $\frac{1}{4}$ c. a lb. is added on orders for less than 40,000 lb.

# ELWELL-PARKER'S *Annual Review* NUMBER



Portable Crane with Telescoping Boom, 19 to 30 ft.



Roll-handling Truck with motorized apron.



Standard Fork Truck with special attachments.

"Well, what's new since last year?"

1. For one thing, Elwell-Parker has brought out *new* Trucks for doing both new jobs and doing old jobs faster and more cheaply. More different *types* of units, more different kinds, and a wide choice of power, according to your needs.

2. Elwell-Parker has brought big-scale load-handling into the *minds* and into the *work* of Executives who have realized major earnings from load transportation this year for the first time. Some who purchased in 1936 have *already* amortized the whole original Truck investment.

3. Elwell-Parker has considerably enlarged its offices;

- has continued the policy of building up its facilities, by adding an increase of fifty per cent to its Engineering Staff during the past year;

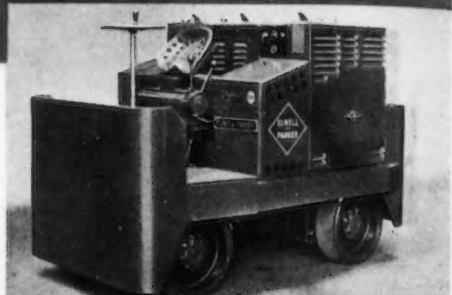
- has built and occupied a large, modern production plant, tooled with equipment especially suited to this business.

4. Many other things are "new" at Elwell-Parker. But sum it all up by saying "here's a concern with the successful background, the skill and the alertness to keep moving ahead, regardless of the years; the knowledge of today's needs, tomorrow's trends."

Since 1906, Elwell-Parker has devoted all it had to building Trucks, Tractors, Cranes—and nothing else. Where else *can* you go for the same help that our Representatives everywhere can bring you right now? Elwell-Parker, 4225 St. Clair Ave., Cleveland, Ohio.



Heavy duty coil handling trucks. Capacities up to 20,000 lbs.



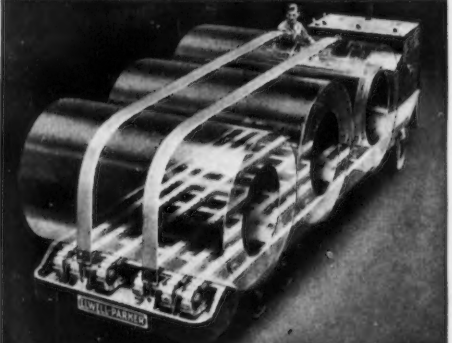
Three and four-wheel Tractors with two and four-wheel drive.



Combination Fork and Crane truck. Forks turn back when not in use.



Straight Gas Lift Truck. Capacities up to 16,000 lbs.



Conveyor chain platform Truck handling steel coils. Full electric control.

## *New Type* ELWELL-PARKER *Trucks*

ESTABLISHED 1893 • BUILDING POWER INDUSTRIAL TRUCKS SINCE 1906

# NEWS OF THE WEEK

## E. T. Weir Says Steel Workers Are Not Being Fooled by CIO's Professed Aims

EXPRESSING a keen interest in the recent employee election at the Weirton Steel Co., E. T. Weir, chairman of the National Steel Corp., in a letter to Jack Larkin, general chairman of the employee representatives, pledged the company's wholehearted cooperation with the elected representatives in their work during 1937. Frankly discussing the current activities of the CIO, Mr. Weir expressed his belief that "None of you employee representatives are fooled by the professed aims of the CIO. I believe, moreover, that comparatively few steel workers have been fooled." Mr. Weir continued, "They know what CIO is after. They know that there is no issue of wages and hours. They know that the CIO wants to bring the steel industry under its domination so that it can exact tribute from the steel workers and dictate terms under which a man can get and hold a job."

Mr. Weir's letter in full follows: "Dear Mr. Larkin:

I wish to convey to you and to each of the other 44 men who were elected to serve as employee representatives for the year 1937 my hearty congratulations on your selection by your fellow employees at Weirton and Steubenville for these important posts of leadership.

Mr. Millsop sent me the tabulation which you gave him showing the percentage of employees who participated in the election.

It is particularly interesting to note that more than 97 per cent of the workers who were eligible to participate in this election actually cast ballots and that of these, almost 1000 were off duty on election day, yet came into the mills expressly to vote.

I am sure you will agree with me when I say that this election is proof that our workers, after a long day-by-day experience with their representation plan, regard it as a practical and effective medium for collective bargaining.

This is not hard to understand

because this plan, as it is conducted at Weirton, is an instrument of, by and for steel workers, readily adaptable to those conditions which are peculiar to steel mills and properly understood only by steel men.

I am especially impressed by the results of this election because it coincides almost identically with results of the election held at Weirton one year ago and the elections held in almost all other plants of the steel industry earlier in this year.

Your election, coming as it does after months of propaganda and high pressure organizing effort emanating from the headquarters of the Committee for Industrial Organization, disproves the claim that the employee representation plans are being destroyed.

Of course I know that none of you employee representatives are fooled by the professed aims of the CIO. I believe, moreover, that comparatively few steel workers have been fooled. They know what CIO is after. They know that there is no issue of wages and hours. They know that the CIO wants to bring the steel industry under its domination, so that it can exact tribute from the steel workers and dictate the terms under which a man can get and hold a job.

I believe that steel workers as a whole resent the fact that CIO has branded them in the public eye as a lot of helpless invertebrates totally incapable of handling their own affairs and forced to beg for leadership of coal miners and milliners. That is rather grotesque in view of the fact that in the steel industry wage rates are nearly 20 per cent higher than in the boom year of 1929, and the fact that the number of dollars in Christmas pay envelopes approached boom year totals.

The newspapers are full of reports of strikes and threats of strikes in such important industries as automobiles, rubber and glass. Any shutdown of those industries would throw millions out of work and have a paralyzing effect upon the whole country.

These sinister threats are being made just at a time when busi-

ness is getting on its feet, when wages and jobs are increasing after long years of depression. The real issue involved in these threats is not better wages and working conditions for employees but the closed shop which would put workers in the power of a ring of labor-politicians.

The menace of these strike threats is the only obstacle I see in the path of continued recovery for the steel industry. Judging from the practically unanimous participation of Weirton employees in the recent election, there is no doubt in my mind that they are determined to avoid any interruption of the present improvement.

I am writing you at length and very frankly because these are matters that bear on the welfare of every member of our organization from top to bottom. As the elected leaders of your fellow employees, you are custodians of the welfare of those employees, and this imposes upon you the obligation to fulfill not only those duties that arise from within the plant but also to guard against dangers that arise from the outside.

As you prepare to assume your duties for the coming year, I pledge to you in behalf of the Weirton management the fullest cooperation with you in your work. Let us look forward to 1937 as a year of increasing prosperity and as one that will continue and strengthen our present friendly and beneficial relationships.

Sincerely yours,  
E. T. WEIR."

## Weirton Furnace Rebuilt, in Blast

AFTER a 54-day shut down for repairs and improvements, following a record run of six years and seven months, the No. 1 blast furnace of the Weirton Steel Co. has resumed operation. The relining of the furnace and the improvement of auxiliary equipment required approximately 336,000 man-hours of labor and the total cost was more than \$750,000. Records were also established in the renovation of the furnace since the whole project was completed in much less than the normal time, and in the relining of the furnace 791,000 nine-inch equivalent brick were laid in the exceptionally short period of 17 days.

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## IRON and STEEL SCRAP

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**... Composite advances 17c. to \$17.92; highest since Feb. 17, 1925.**

o o o

**... Strikes in automobile plants fail to weaken scrap's position.**

o o o

**... Market activity concentrated in filling old orders.**

PRICES in principal consuming centers continue to be conspicuously buoyant on the basis of broker bidding to cover short positions. In Philadelphia, a nominal broker advance of 50c. for No. 1 steel is reflected in a higher composite figure, which for the current week is 17c. higher at \$17.92 a gross ton, the highest level reached since Feb. 17, 1925. At Pittsburgh, the market is temporarily quiet, but no significant uncertainty has yet developed because of labor difficulties at Detroit. No Pittsburgh broker is willing to sell into consumption at less than \$19.50 for No. 1 steel, and a \$19 offer to cover old commitments is now a regular market occurrence.

The entire price structure at Chicago is strong and practically all grades of material are moving in large quantities. For the past

several days, consumer purchases of No. 1 steel have been limited to a top figure of \$18, but active broker bidding for railroad steel has brought out \$18.75 a gross ton, delivered, in one instance. The Detroit market is unchanged, with low phos plate being the most active item. Brokers in the Cleveland area have considerable business on their books, and do not seem anxious to make further sales until some of these old orders are cleaned up.

The export market along the Atlantic Seaboard has again shown signs of picking up after several months of comparative inactivity. A number of firm foreign offers at high price levels have been issued to principal sellers, and in several instances new commitments were definitely made.

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### A.F.A. To Give Prizes For Safety Ideas

THE American Foundrymen's Association announces that the 1937 A.F.A. Obermayer prize will be awarded to the person submitting the best idea or device for safety or health protection, or idea which could be used to stimulate interest in safety of foundry or pattern shop workers. Two awards will be made, a first prize of \$50 and a second prize of \$25.

Contestants must be foremen, journeymen, apprentices or shop workers in a foundry or in some department of a plant operated in connection with a foundry or pattern shop, and must be either members of the A.F.A. or employed by a firm holding membership.

Entries in the contest may be submitted as a model, picture, drawing, or illustrated written de-

scription, and must be one which is not patented. These will be displayed at the Milwaukee convention the week of May 3. The awarding of the prizes will be determined by popular vote as cast by those viewing the entries at the convention.

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### Shorter Hours Would Lower Workers' Pay

IF a shorter work week were required by law it would reduce earning capacities and standards of living of employees in the steel industry, according to Frank Purnell, president of the Youngstown Sheet & Tube Co.

"The steel industry," Mr. Purnell said, "supports President Roosevelt's desire for good working standards and, of course, it does not employ any child labor. Its leaders believe that proper working conditions constitute the surest

foundation for general prosperity.

"Steel mills now are operating on a basis of an 8-hr. day and not more than six days in any one week. In order to provide a reasonable average of hours work each week, it is necessary because of seasonal demands for steel products to work at least 48 hr. per week when demands are heavy, as is demonstrated by the fact that during 1936, when the steel industry was operating at a high level, the average weekly rate of employment during the year was about 40 hr. It is obvious that, if any shorter work week were required by law, because of seasonal conditions the average employment per week throughout the year would be considerably below 40 hr., so that earning capacities and consequently standards of living of the employees would be adversely affected."

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### Tempering Steel With Apple Juice

THAT apple juice may probably be used in place of oil in the tempering of steel in Czechoslovakia is indicated in a report to the Commerce Department from Acting Commercial Attache Jule B. Smith, Prague. It is reported locally, Mr. Smith states, that the Technical University in Prague and the machinery concern Skoda Works of the same city have made satisfactory tests with a new method which replaces oil by apple juice in the tempering of steel. The apple juice preparation is called "Kolodit" by the Czechoslovak inventor. If his method proves of practical value, the report states, it may be of importance to the Czechoslovak iron and steel works as oil for steel tempering must be imported.

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Canton Forge & Axle Co., Canton, Ohio, which has been a wholly owned subsidiary of Poor & Co., has been absorbed by the latter company and its business hereafter will be carried on as the Canton Forge & Axle Works of Poor & Co. No change has been made in management or personnel.

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The Morgan Construction Co., Worcester, Mass., has granted to the Mesta Machine Co. a license for the manufacture of oil film bearings under its patents. This bearing is a totally inclosed precision oil film bearing for use on the necks of the rolls in a rolling mill.

# Iron and Steel Scrap Prices

## PITTSBURGH

Per gross ton delivered to consumer:	
No. 1 hvy. mltng. steel.	\$19.00 to \$19.50
No. 2 hvy. mltng. steel.	17.50 to 18.00
No. 2 RR. wrought.	19.00 to 19.50
Scrap rails	19.25 to 19.75
Rails, 3 ft. and under.	21.50 to 22.00
Comp. sheet steel	19.00 to 19.50
Hand. bundled sheets.	18.00 to 18.50
Hvy. steel axle turn.	17.50 to 18.00
Machine shop turn.	14.00 to 14.50
Short shov. turn.	14.00 to 14.50
Mixed bor. & turn.	13.50 to 14.00
Cast iron borings	14.00 to 14.50
Cast iron carwheels.	17.50 to 18.00
Hvy. breakable cast.	15.00 to 15.50
No. 1 cast	17.00 to 17.50
RR. knuckles & cplrs.	23.50 to 24.00
Rail coil & leaf springs.	23.50 to 24.00
Rolled steel wheels.	23.50 to 24.00
Low phos. billet crops.	24.00 to 24.50
Low phos. sh. bar.	23.50 to 24.00
Low phos. punchings.	23.00 to 23.50
Low phos. plate scrap.	23.00 to 23.50
Steel car axles	22.00 to 22.50

## CLEVELAND

Per gross ton delivered to consumer:	
No. 1 hvy. mltng. steel.	\$17.50 to \$18.00
No. 2 hvy. mltng. steel.	16.50 to 17.00
Comp. sheet steel	17.25 to 17.75
Light bund. stampings	13.50 to 14.50
Drop forge flashings.	17.00 to 17.50
Machine shop turn.	11.50 to 12.00
Short shov. turn.	12.00 to 12.50
No. 1 busheling	16.50 to 17.00
Steel axle turnings	15.00 to 15.50
Low phos. billet crops	22.00 to 22.50
Cast iron borings	12.00 to 12.50
Mixed bor. & turn.	12.00 to 12.50
No. 2 busheling	12.00 to 12.50
No. 1 cast	18.00 to 18.50
Railroad grate bars.	12.00 to 12.50
Stove plate	10.00 to 10.50
Rails under 3 ft.	22.00 to 22.50
Rails for rolling	20.00 to 20.50
Railroad malleable	18.00 to 18.50
Cast iron carwheels.	18.50 to 19.00

## PHILADELPHIA

Per gross ton delivered to consumer:	
No. 1 hvy. mltng. steel.	\$16.50 to \$17.00
No. 2 hvy. mltng. steel.	15.00 to 15.50
Hydraulic bund., new.	15.75 to 16.25
Hydraulic bund., old.	13.50 to 14.00
Steel rails for rolling.	17.00 to 17.50
Cast iron carwheels.	18.00 to 18.50
Hvy. breakable cast.	16.50 to 17.00
No. 1 cast	18.00 to 18.50
Stove plate (steel wks.)	13.50 to 14.00
Railroad malleable	17.00 to 18.00
Machine shop turn.	10.50 to 11.00
No. 1 blast furnace.	10.50 to 11.00
Cast borings	10.00 to 10.50
Heavy axle turnings.	14.50
No. 1 low phos. hvy.	20.00 to 20.50
Couplers & knuckles	21.00 to 21.50
Rolled steel wheels	21.00 to 21.50
Steel axles	21.50 to 22.00
Shafting	21.50 to 22.00
No. 1 RR. wrought.	16.00 to 16.50
Spec. iron & steel pipe	14.50 to 15.00
Bundled sheets	14.00 to 14.50
No. 1 forge fire.	14.50 to 15.00
Cast borings (chem.).	10.50 to 13.00

## CHICAGO

Delivered to Chicago district consumers:	
Per Gross Ton	
Hvy. mltng. steel.	\$17.50 to \$18.00
Auto. hvy. mltng. steel.	14.75 to 15.25
Alloy free	15.75 to 16.25
Shoveling steel	17.50 to 18.00
Hydraul. comp. sheets.	16.75 to 17.25
Drop forge flashings.	14.50 to 15.00
No. 1 busheling	16.50 to 17.00
Rolled carwheel's	20.00 to 20.50
Railroad tires, cut	20.00 to 20.50
Railroad leaf springs.	20.00 to 20.50
Axle turnings	20.00 to 20.50
Steel coup. & knuckles	19.00 to 19.50
Coil springs	22.00 to 22.50
Axle turn. (elec.)	17.25 to 17.75
Low phos. punchings.	21.75 to 22.25
Low phos. plates, 12 in. and under	21.75 to 22.25
Cast iron borings	9.50 to 10.00
Short shov. turnings.	11.00 to 11.50
Machine shop turn.	8.50 to 9.00
Rerolling rails	18.25 to 18.75
Steel rails under 3 ft.	19.50 to 20.00
Steel rails under 2 ft.	21.50 to 22.00
Angle bars, steel.	20.00 to 20.50
Cast iron carwheels	18.00 to 18.50
Railroad malleable	20.00 to 20.50
Agric. malleable	15.50 to 16.00
Per Net Ton	
Iron car axles	20.50 to 21.00

Steel car axles	\$19.50 to \$20.00
No. 1 RR. wrought.	16.50 to 17.00
No. 2 RR. wrought.	15.75 to 16.25
No. 2 busheling, old.	6.75 to 7.25
Locomotive tires	14.00 to 14.50
Pipes and flues	11.00 to 11.50
No. 1 machinery cast.	15.50 to 16.00
Clean auto. cast	14.75 to 15.25
No. 1 railroad cast	14.50 to 15.00
No. 1 agric. cast	12.50 to 13.00
Stove plate	10.00 to 10.50
Grate bars	11.50 to 12.00
Brake shoes	12.00 to 12.50

## BUFFALO

Per gross ton. f.o.b. consumers' plants:	
No. 1 hvy. mltng. steel.	\$17.50 to \$18.00
No. 2 hvy. mltng. steel.	16.50 to 17.00
Scrap rails	17.50 to 18.00
New hvy. b'ndled sheets	16.50 to 17.00
Old hydraul. bundles	13.50 to 14.00
Drop forge flashings	16.50 to 17.00
No. 1 busheling	16.50 to 17.00
Hvy. axle turnings.	11.00 to 11.50
Machine shop turn.	11.50 to 12.00
Knuckles & couplers.	20.50 to 21.00
Coil & leaf springs.	20.50 to 21.00
Rolled steel wheels.	20.50 to 21.00
Low phos. billet crops.	20.50 to 21.00
Short shov. turnings.	11.50 to 12.00
Mixed bor. & turn.	11.50 to 12.00
Cast iron borings	11.50 to 12.00
Steel car axles	20.50 to 21.00
No. 1 machinery cast.	16.25 to 16.75
No. 1 cupola cast	15.50 to 16.00
Stove plate	13.00 to 13.50
Steel rails under 3 ft.	19.00 to 19.50
Cast iron carwheels.	16.00 to 16.50
Railroad malleable	18.50 to 19.00
Chemical borings	10.50 to 11.00

## BIRMINGHAM

Per gross ton delivered to consumer:	
Hvy. melting steel.	\$12.50 to \$13.00
Scrap steel rails	12.50 to 13.00
Short shov. turnings.	8.00
Stove plate	8.50
Steel axles	15.00
Iron axles	15.00
No. 1 RR. wrought.	10.00
Rails for rolling	14.00
No. 1 cast	13.50
Tramcar wheels	13.00

## ST. LOUIS

Dealer's buying prices per gross ton delivered to consumer:	
Selected hvy. steel.	\$16.00 to \$16.50
No. 1 hvy. melting.	15.50 to 16.00
No. 2 hvy. melting.	14.25 to 14.75
No. 1 locomotive tires.	15.00 to 15.50
Misc. stand.-sec. rails.	16.75 to 17.25
Railroad springs	18.25 to 18.75
Bundled sheets	9.50 to 10.00
No. 2 RR. wrought	15.50 to 16.00
No. 1 busheling	8.50 to 9.00
Cast bor. & turn.	5.50 to 6.00
Rails for rolling	17.25 to 17.75
Machine shop turn.	4.00 to 4.50
Heavy turnings	10.50 to 11.00
Steel car axles	19.00 to 19.50
Iron car axles	19.50 to 20.00
No. 1 RR. wrought	13.50 to 14.00
Steel rails under 3 ft.	17.00 to 17.50
Steel angle bars	16.25 to 16.75
Cast iron carwheels.	15.25 to 15.75
No. 1 machinery cast.	13.00 to 13.50
Railroad malleable	15.50 to 16.00
No. 1 railroad cast.	13.25 to 13.75
Stove plate	7.50 to 8.00
Agricul. malleable	12.50 to 13.00
Grate bars	10.50 to 11.00
Brake shoes	13.00 to 13.50

## CINCINNATI

Dealers' buying prices per gross ton:	
No. 1 hvy. mltng. steel.	\$15.00 to \$16.00
No. 2 hvy. mltng. steel.	12.75 to 13.25
Scrap rails for mltng.	15.50 to 16.00
Loose sheet clippings.	9.50 to 10.00
Bundled sheets	11.50 to 12.00
Cast iron borings	7.50 to 8.00
Machine shop turns	8.50 to 9.00
No. 1 busheling	12.00 to 12.50
No. 2 busheling	7.50 to 8.00
Rails for rolling	16.00 to 16.50
No. 1 locomotive tires.	13.75 to 14.25
Short tails	18.75 to 19.25
Cast iron carwheels	14.75 to 15.25
No. 1 machinery cast.	15.75 to 16.25
No. 1 railroad cast	14.75 to 15.25
Burnt cast	10.75 to 11.25
Stove plate	10.75 to 11.25
Agricul. malleable	14.75 to 15.25
Railroad malleable	16.25 to 16.75

## DETROIT

Dealers' buying prices per gross ton:	
No. 1 hvy. mltng. steel.	\$14.50 to \$15.00
No. 2 hvy. mltng. steel.	13.75 to 14.25
Borings and turnings.	10.50 to 11.00
Long turnings	10.00 to 10.50
Short shov. turnings.	11.25 to 11.75
No. 1 machinery cast.	15.00 to 15.50
Automotive cast	15.00 to 15.50
Hydraul. comp. sheets.	15.50 to 16.00
Stove plate	9.25 to 9.75
New factory bushel.	14.75 to 15.25
Old No. 2 busheling	9.00 to 9.50
Sheet clippings	11.75 to 12.25
Flashings	14.00 to 14.50
Low phos. plate scrap.	16.25 to 16.75

## CANADA

Dealers' buying prices per gross ton:	
	Toronto
No. 1 hvy. mltng. steel.	\$10.75 to \$10.50
No. 2 hvy. mltng. steel.	9.75 to 9.25
Mixed dealers steel	7.75 to 7.75
Scrap pipe	6.75 to 6.50
Steel turnings	4.25 to 4.25
Cast iron turnings	4.75 to 4.50
Machinery cast	11.75 to 11.00
Dealers cast	10.75 to 10.00
Stove plate	7.25 to 6.75

## YOUNGSTOWN

Per gross ton delivered to consumer:	
No. 1 hvy. mltng. steel.	\$18.50 to \$19.00
Hydraulic bund'es	18.25 to 18.75
Machine shop turn.	14.00 to 14.50

## NEW YORK

Dealers' buying prices per gross ton:	
No. 1 hvy. mltng. steel.	\$12.50 to \$13.00
No. 2 hvy. mltng. steel.	11.00 to 11.50
Hvy. breakable cast.	13.00 to 13.50
No. 1 machinery cast.	13.50 to 14.00
No. 2 cast	11.00 to 11.50
Stove plate	10.25 to 10.75
Steel car axles	18.00 to 19.00
Shafting	17.00 to 18.00
No. 1 RR. wrought	12.00 to 12.50
No. 1 wrought long.	11.00 to 11.50
Spec. iron & steel pipe	10.50 to 11.00
Forge fire	9.50 to 10.00
Rails for rolling	13.50 to 14.00
Short shov. turnings.	6.00 to 6.50
Machine shop turn.	6.00 to 6.50
Cast borings	6.00 to 6.50
No. 1 blast furnace	6.00 to 6.50
Cast borings (chem.).	10.00 to 11.00
Unprepar. yard scrap.	6.00 to 6.50

Per gross ton, delivered local foundries:  
No. 1 machn. cast. \$14.50 to \$15.00  
No. 1 hvy. cast cupola. 12.00 to 12.50  
No. 2 cast 11.00 to 11.50  
Add 25c. to 50c. above quotations to secure North Jersey prices.

## BOSTON

Dealers' buying prices per gross ton:	
No. 1 hvy. mltng. steel.	\$12.80 to \$13.05
Scrap rails	12.80 to 13.25
No. 2 steel	11.30 to 11.55
Breakable cast	12.09 to 12.34
Machine shop turn.	7.55 to 7.80
Unmixed bor. & turn.	7.30 to 8.30
Bund. skeleton long.	11.40 to 11.65
Shafting	16.50 to 16.75
Cast bor. chemical.	6.00 to 7.00
Per gross ton delivered consumers' yards:	
Textile cast	\$13.00 to \$13.75
No. 1 machine cast	13.50
Stove plate	9.50 to 10.00

## EXPORT

Dealers' buying prices per gross ton:	
New York, delivered alongside barges	
No. 1 hvy. mltng. steel.	\$12.50
No. 2 hvy. mltng. steel.	11.50
No. 2 cast	11.00
Stove plate	10.00
Rails (scrap)	12.50
Boston on cars at Army Base or Mystic Wharf	
No. 1 hvy. mltng. steel.	\$12.00 to \$12.25
No. 2 hvy. mltng. steel.	11.00 to 11.25
Rails (scrap)	12.50 to 12.75
Stove plate	7.75 to 8.00
New Orleans, on cars at Stuyvesant Dock	
No. 1 hvy. mltng. steel.	\$13.60 to \$13.75
No. 2 hvy. mltng. steel.	12.60 to 12.75
Los Angeles, on cars or trucks at local piers	
No. 1 hvy. mltng. steel.	\$10.50 to \$11.00
Compressed bundles	8.50 to 9.00

# Anti-Lewis Employees of U. S. Steel Plan Campaign to Combat CIO

**G**IRDING themselves for what promises to be "a knock-and drag-out fight" between anti-Lewis and pro-Lewis adherents, 32 employee representatives from Carnegie-Illinois' Pittsburgh and Youngstown plants met in Pittsburgh last week and proposed a resolution, the purpose of which is to defend the employee representation plan against all attacks by outside organizations. The defense committee's resolution attacked Lewis' Committee on Industrial Organization and accused it of making malicious and erroneous attacks upon the plan of employee representation and the honesty and integrity of employee representatives. It further stated that these attacks have been misleading to both the public and employees and called upon all employee representatives to defend the plan and refute the false statements being made. The defense committee said that, although the plan was not 100 per cent, it is the best means to achieve social justice for fellow workers.

The resolution is to be acted upon by all general bodies of employees. Two plants, the Farrell works and the Wood works at McKeesport, Pa., have already approved the aims and objects expressed in the resolution. At the employee meeting last week it was also recommended that a weekly news letter be published to acquaint the various plant bodies with activities going on in defense of the plan. A "flying squadron" composed of eight members to visit various plants and speak on behalf of the employee representation plan was suggested and is now in operation. A steering committee of four has been appointed to contact the various general bodies and to outline schedules for the "flying squadron's" visit.

The Pittsburgh district employee council composed of representatives from all Carnegie-Illinois' Pittsburgh and Youngstown plants is meeting this week to act on the resolution for the defense of the plan. Bitter attacks by the Steel Workers' Organizing Committee have been made against the effectiveness of the plan, and Elmer J. Maloy, pro-Lewis chairman of the Pittsburgh district council, released a caustic criticism against the defense committee meeting last week at which he was not present. He branded the committee a "hand-picked" group, completely domi-

nated by the management. Answering the criticism, F. W. Bohne, chairman of the Pittsburgh joint council committee, called Mr. Maloy's remarks "malicious lies." He said, "no employee attending last week's meeting has been or will be dominated by management. Accusations made against me to the effect that management controls my thoughts and actions in carrying out my duties as an employee representative are entirely false and misleading. Management has never attempted to dominate my actions, nor could they if they desired to."

Meanwhile, defenders of the plan of employee representation are going to make sure that their own views are given publicity when the National Labor Board hear-

ings resume at Washington. Their belief that the public was and is being misinformed about the benefits of the plan of employee representation, is responsible for their militant action. The uniting of adherents of the plan of employee representation in the Carnegie-Illinois Steel Corp. will be the second such group formed for defense purposes, the first being the security league of Weirton Steel employees, the majority of which late last week staged a demonstration in favor of the employee plan at Weirton, W. Va.

The SWOC gained new adherents over the week-end as some of the Jones & Laughlin Steel Corp.'s employee representatives went over to the Lewis side. This action followed the refusal a few weeks ago of the company to deal with a central bargaining committee. As a compromise to this request, the company had increased the power of plant managers to deal with employee problems.



**Conway Village Fire District, Conway, N. H.,** closed bids Jan. 6 for a water supply system, including 6 and 8-in. pipe. George A. Orcutt is chairman of water supply commission, and Harlan M. Bryant, Main Street, Milton, N. H., is engineer.

**Port Isabel, Tex.,** plans pipe lines for water system, including main trunk line from new pumping station to be built on Rio Grande River to city, crossing Brownsville ship channel. Cost about \$72,000. Fund of \$32,000 has been secured through Federal aid and remainder of appropriation will be arranged through municipal financing.

**White City, Kan.,** plans pipe lines for water system; also elevated steel tank and tower and other waterworks installation. Fund of \$52,000 is being arranged through Federal aid. Paulette & Wilson, National Reserve Building, Topeka, Kan., and Farmers' Union Building, Salina, Kan., are consulting engineers.

**Buffalo** plans extensions in pipe lines in Elmwood Avenue for water system. Cost about \$170,000. Financing will be arranged through Federal aid.

**Seguin, Tex.,** Plans pipe lines for extensions and replacements in water system. Financing is being arranged through Federal aid.

**Garfield Heights, Ohio,** closes bids Jan. 16 for pipe lines for water system and other waterworks installation. Cost about \$42,000. John A. Petsche is engineer.

**Clay County Public Water District No. 1,** care of L. E. Bates, National Bank Building, North Kansas City, Mo., attorney and representative, has sold bond issue to make total fund of \$410,000 for pipe lines for water system in suburban area in Clay County, near North Kansas City, and other waterworks installation, including main trunk line to connect with system at Kansas City, to be used as

source of supply. Henrici-Lowry Engineering Co., 114 West Tenth Street, Kansas City, is consulting engineer.

**Sisseton, S. D.,** will take bids soon for 31,900 ft. of 4 and 8-in. for water system; also for other waterworks equipment. Cost about \$80,000. Financing has been arranged through Federal aid. Dakota Engineering Co., Mitchell, S. D., is consulting engineer.

**Dwight, Neb.,** plans pipe lines for water system; also other waterworks installation. Cost about \$22,000. Henningson Engineering Co., Union State Bank Building, Omaha, Neb., is consulting engineer.

**Wisner, La.,** plans pipe lines for water system; also other waterworks installation. Cost about \$45,000. Special election has been called Jan. 12 to approve bonds in amount noted. Swanson & McGraw, Balter Building, New Orleans, are consulting engineers.

**Alpha, N. J.,** plans about four miles of pipe in different streets for water system; also steel standpipe and other waterworks installation. Fund of \$80,000 has been secured through Federal aid. S. R. Pursel, R. D. No. 1, Phillipsburg, N. J., is consulting engineer.

**Port St. Joe, Fla.,** plans pipe lines for water system and other waterworks installation, including facilities for water supply for industrial service. Cost about \$140,000. Financing is being arranged through bond issue and Federal aid.

The Interstate Commerce Commission has authorized the merger of the properties of the Union Railroad Co., the Monongahela Southern Railroad Co., and the St. Clair Terminal Railroad Co., into the Union Co., all of whose capital stock is owned by the United States Steel Corp. The rail lines are switching roads in the Pittsburgh district and serve United States Steel Corp. subsidiary plants as well as other industries as terminals for trunk line carriers.

# Technical Progress of The Metal-Working Industry In 1936

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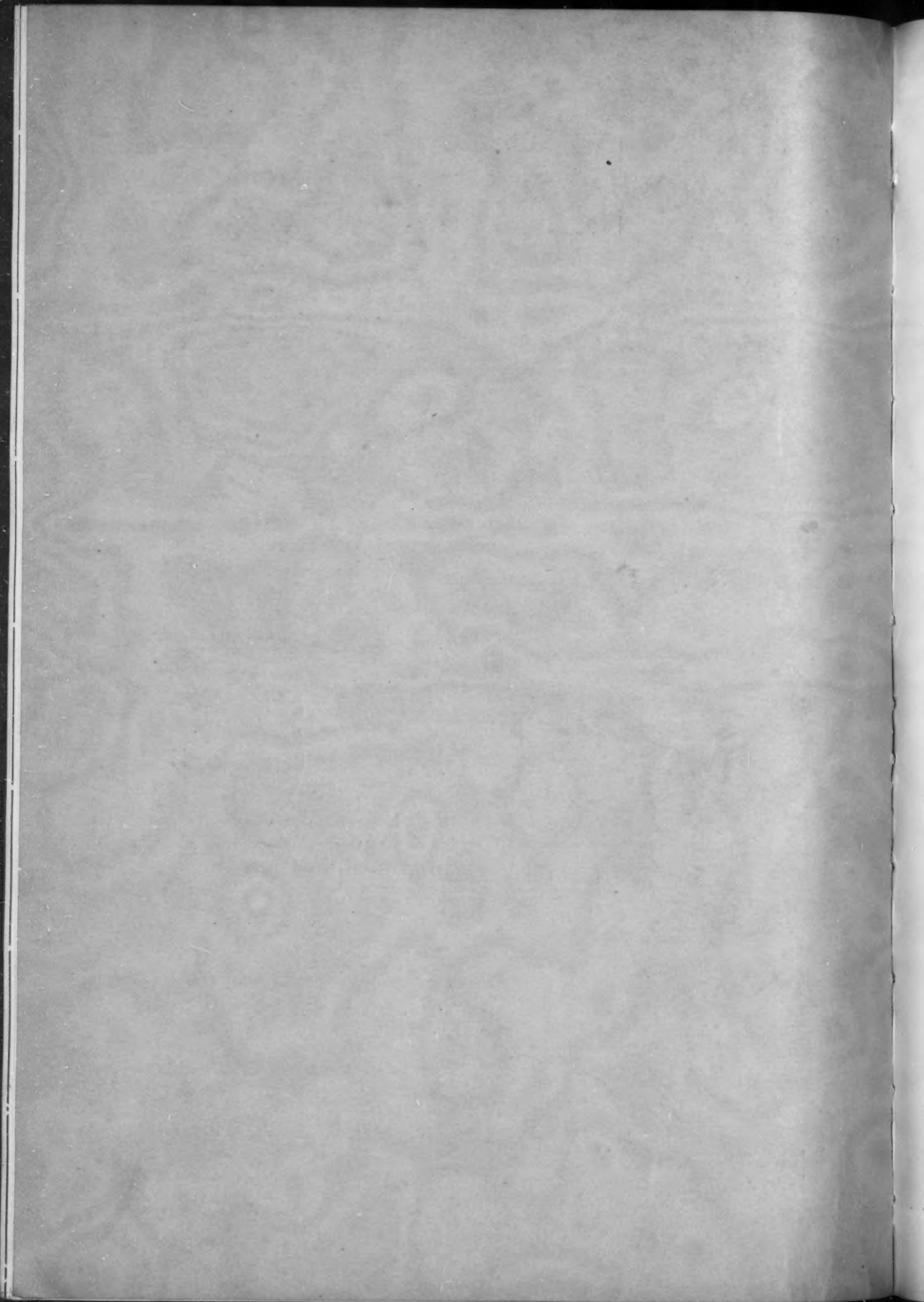
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***IN the following fourteen sections  
will be found the record of progress in technique and equipment in  
the principal divisions of the Metal-  
Working Industry.***

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## WHAT THIS ISSUE MEANS . . .

**T**HIS issue of The Iron Age is a monument to accomplishment.

It has been built, not by the editors, but by the industry.

We are particularly gratified to be able to present an unparalleled record of technical progress, in every branch of the metal-working industry. This is set forth in the 14 technical sections which follow.

Progress in our industry is divided into three major parts. One is progress in materials, one is progress in methods, one is progress in machinery.

Each of these great divisions has surged forward during 1936 as perhaps in no other single year in the memory of any one of us.

Progress in any one of the three means progress in the other two, because all three are interdependent.

The effect of this marked progress on three fronts is something that is incalculable, but it will mean much to America in 1937 and during the years that follow.

This progress comes at a time when it is sorely needed. It comes at a time when constructive effort is engaged in a vital tug-of-war with destructive effort; when the principle of free enterprise is at grips with the principles of regimentation; when the philosophy of abundance through invention and effort stands opposed to the doctrine of scarcity and the religion of defeatism.

It is our sincere hope that this issue of The Iron Age, through its depiction of the amazing record of one year of accomplishment, may spur our industry to renewed and redoubled effort. And that through a continuation and extension of this effort and this achievement, we may all help preserve America from the want that breeds war and the despair that breeds dictatorships.

# METALS

WITH MYSTIC ROD  
HE SMOTE THE ROCK,  
AND LIVING WATERS FLOWED  
TO QUENCH THE THIRST  
OF ISRAEL'S SONS  
AND LIGHTEN MOSES' LOAD.  
A LATER MOSES TOUCHED THE EARTH  
WITH WAND OF FLAME AND FIRE,  
AND OUT SPRANG MOLTEN METAL STREAMS  
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- 1930—New continuous bar mill (the most modern built to date) was completed.
- 1932—New continuous sheet and strip mills started their highly successful record of operation.
- 1933—New tin mills were installed.
- 1936—New blooming mill, soaking pits and four new open hearths placed in service.
- 1937—New blast furnace, the first to be built in this country in about six years, now under construction; also new battery of coke ovens.

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# METALS . . .

*New stainless steels, non-aging mild steels, harder bronzes, improved gunmetals, and growing application of die-cast metals are among developments of 1936*

° ° °  
By T. W. LIPPERT

*Metallurgical Editor, The Iron Age*  
° ° °

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AS steel operations mount to challenge the 1929 production records, it is increasingly evident that some proportion of this recovery should be credited to research undertaken during the dark years of 1932 and 1933. Although the installation of large efficient production units such as continuous strip-sheet mills, re-vamped wire, rod and tube machines, etc., constitute the most dramatic technological changes of the past several years, behind this facade is a long list of metallurgical developments which have literally laid down a firm base for a renaissance in steel making. To mention a few, consider the long list of high-strength low-alloy construction steels introduced to the public in 1934 and which encouraged to some extent the redesign and construction of the railroad's rolling stock; the great advances in widening the application and improving the dependability of stainless steels; the introduction of new valve alloys with many times

the life of conventional materials; the steady improvement in ductility of cold-rolled sheets and the reduction in aging of this type of steel; and a multitude of other changes and improvements which broadened the use and encouraged the consumption of steel.

These examples for the most part are the most visible return the ferrous and non-ferrous industries received for the \$9,200,000 spent for research in 1935. But behind these evidences of progress visible to the casual observer are a number of widely scattered, un-integrated, closely defined laboratory investigations which yet have not gone beyond being abstract discussions in scientific journals. This experimental work cannot be measured in dollars and cents, but nonetheless it is expanding the backlog of technical knowledge to permit the future introduction of valuable commercial metals and processes.

These two phases of development in the field of metals, the commer-

cial and the theoretical, are the concern of this review, and some of the more interesting discoveries of 1936 will be treated in the following paragraphs.

Consider first several of the laboratory reports on the oldest of ferrous metals, cast iron, which during the past decade has dragged itself from widespread disfavor to a position of high repute by means of militant research. It has always been generally considered that ordinary cast iron is serviceable only at low temperatures (for instance in steam equipment) owing largely to dimensional changes at higher temperatures (growth) accompanied by loss of strength. For this reason, cast iron for pressure vessels in the United States is limited to temperatures under 450 deg. F.

Owing to the scarcity of information regarding the properties of ordinary and alloy cast irons at the temperatures of superheated steam, three workers at the National Physical Laboratory (England) last year conducted a range

of experiments to determine creep and growth at elevated temperatures for five different irons, namely, ordinary gray iron (3.29 total C, 1.27 Si, 0.28 Mn, 0.12 S, and 0.72 P), nickel-chromium iron (3.19 total C, 2.13 Si, 0.58 Mn, 0.090 S, 0.80 P, 0.67 Ni and 0.34 Cr), Silal (2.39 total C, 5.72 Si, 0.67 Mn, 0.063 S, and 0.30 P), Nicro-silal (1.75 total C, 5.84 Si, 0.68 Mn, 0.039 S, 0.045 P, 17.72 Ni and 2.10 Cr), and Niresist (2.44 total C, 1.11 Si, 0.76 Mn, 0.057 S, 0.26 P, 16.56 Ni, 3.30 Cr and 7.30 Cu). These irons were studied between the temperatures 700 deg. F. and 1000 deg. F.

The results of the investigation showed that the rates of creep and growth of ordinary gray cast iron and nickel-chromium cast iron may be considerably reduced by preliminary heat treatment below the critical temperature for a suitable period, and, for that reason, these irons in the heat-treated condition may have additional useful application. The heat treatment lowers the tensile strength at air temperature of the ordinary cast iron, but has much less effect on the strength of the nickel-chromium cast iron. The silal cast iron has properties of the same order as those of the ordinary and nickel-chromium cast irons in their heat-treated condition.

The creep and growth of the austenitic Nicrosilal cast iron at 842 deg. F. and 1000 deg. F. were found to be little different from those of ordinary cast iron in the as-cast condition; the poor properties of the Nicrosilal iron were judged as being probably due to the instability of the austenite at both temperatures. Good resistance to growth and creep at 842 and 1000 deg. F. was shown by the Niresist iron, which is also austenitic; actually, it possessed better resistance to growth at 1000 deg. F. than at 842 deg. At 1560 deg. the Nicrosilal iron was superior to both the Silal and Niresist irons.

As an example of an iron used for a specialized high-temperature application, consider an analysis discussed during the year by Evans, Goacher and Hurst for use in making glass bottle molds. An alloy iron would probably be preferable to plain iron in making molds of this type, but for cost reasons plain irons are used. The glass temperature within the mold varies from 1290 to 1830 deg. F., the outside

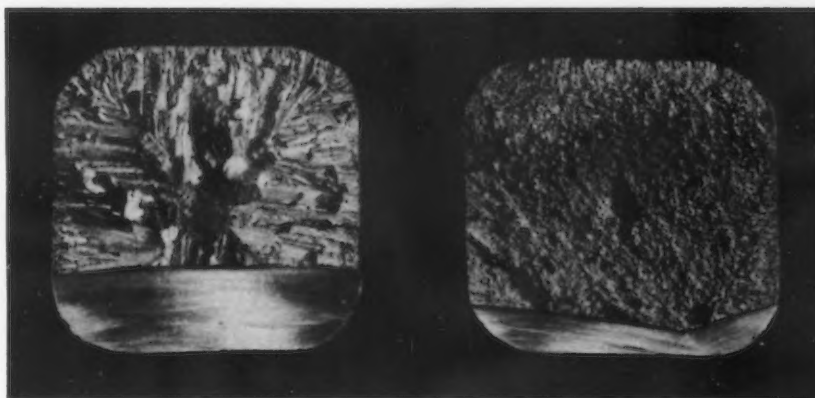


FIG. 1

THESE specimens show the effect of nitrogen additions in reducing the grain size of 20 per cent chromium steel. The specimen on the left is without nitrogen and the one on the right contains nitrogen.

temperature of the mold from 570 to 930 deg. F. Recommended composition of iron is not over 3.10 per cent total carbon, 0.80 to 1.50 Mn, 0.07 maximum S, 0.45 maximum P, with silicon ranging from 1.30 per cent for a casting  $2\frac{1}{2}$  in. thick up to 2.50 per cent for a thickness of  $\frac{1}{2}$  in. Brinell hardness varies from 215 to 235. Failure of molds is related to propensity toward growth of the iron. The iron should be close so as to take a good polish, hence the total carbon is kept down. A discussion of this report pointed out that the interior surface should be made dense by chilling and that by varying the chill according to the wall thickness of the mold, metal of one silicon content could be used for a variety of thicknesses. The authors, however, maintain that it is better to adjust the silicon than to chill. These cast iron molds are meant for short runs, but aus-

tenitic heat-resistant alloys are recommended for long runs.

A cast alloy iron for chill castings was patented by Fried. Krupp Grusonwerk A.-G., Germany, during the year. The invention is based on the principle of replacing nickel (which is added to increase strength and surface hardness) partially by manganese, in such a manner as to form martensite in the same way as nickel, but differing from nickel in that manganese increases the depth of chill; that is to say, it promotes the carbide formation and renders it possible to dispense with chromium. A martensite cast iron alloy according to the invention contains 2 to 4 per cent C, 0.25 to 2 Si, 1.25 to 2.5 Ni, and a proportion of manganese varying inversely to the proportion of nickel from 5.9 to 3.6 per cent.

Of the many cast alloys devel-



FIG. 2

THIS welded stainless steel amphibian airplane is fully streamlined and has the most modern improvements and instruments, including retractable landing gear; yet it weighs only 2285 lb. empty, which is less than even a land plane of conventional construction and comparable capacity would weigh.

oped during the year in the automobile industry, probably the most interesting is the piston alloy introduced by the Ford Motor Co. This alloy, in addition to iron, contains 1.35 to 1.7 per cent C, 0.6 to 1.0 Mn, 0.9 to 1.3 Si, 0.08 maximum S, 0.1 maximum P, 2.5 to 3.0 Cu and 0.15 to 0.2 per cent Cr. This alloy may be described as a high carbon-copper-silicon steel, and it is considered as being much superior to aluminum alloy or cast

carbon in a matrix of spheroidized pearlite. The elastic limit is 70,000 lb. per sq. in., tensile strength is 90,000 lb. per sq. in., an elongation of 5 per cent in 2 in., and a Brinell hardness of 207 to 241.

#### New Stainless Alloys

A new silico-iron alloy, called Durichlor, has been announced as exceptionally resistant to hydrochloric acid. The composition is 13.5 per cent Si, 3.5 Mo and 1.0

sons are not enthusiastic about the tableware for this reason." Roneusil contains no nickel, but is made up of 8 to 9 per cent of Cr and 12 per cent Mn (with carbon content and presence of other elements yet unannounced). It is rustproof and resistant to acids ordinarily occurring in foods. It is easily worked, may be soldered or welded, and has a tensile strength of 92,000 lb. per sq. in. and an elongation of about 40 to 60 per cent. The metal possesses a whiter color than carbon steel and resembles silver in appearance, takes a high polish and does not tarnish or become dull. Consequently its principle use will be in the manufacture of tableware, pots, trays, casseroles, etc. Since Roneusil cannot be heat hardened, knife blades must be made of another material.

#### Straight Chrome Alloys

As in the case of stainless steels, certain modifications of analysis, such as new gradations of chromium content and suitable additions of other elements, are making many of the straight chromium steels more valuable, more economical and more widely applicable.

Modifications of the widely used 4 to 6 per cent chromium steels that have been chronicled in recent technical publications or displayed in engineering exhibits include a molybdenum-bearing 9 per cent chromium steel suitable for severe service in petroleum refineries and power plants. For high-pressure service, where resistance to shock and the decarburizing effect of hydrogen at high temperature is required, good results are obtained with 1.50 to 2.75 per cent chromium, and the addition of molybdenum and vanadium. Another modification is a columbium-bearing 2 per cent chromium steel. The 4 to 6 per cent chromium steels themselves have been modified and improved by additions of columbium or titanium. The creep strengths of 4 to 6 per cent chromium steels containing tungsten or molybdenum, which are used for condensers and tubing in oil cracking, are improved when columbium is added.

The addition of columbium or titanium is responsible for much of the improvement in the properties of many of the chromium-nickel and straight chromium steels, and is the most successful



FIG. 3

THE smallest die casting of 1936, the Ingersoll watch stem guard. Weight, 4 grams of zinc alloy per watch.

iron for the casting of automobile pistons.

This alloy casts and machines well, has mechanical properties that enable a thin-walled piston to be used, a high resistance to wear and a satisfactory coefficient of expansion. This alloy thus in some measure combines the advantages of aluminum and cast iron pistons. After casting in green-sand molds, the pistons have a structure consisting of pearlite and cementite. They are heat-treated to 1650 deg. F. for 20 min., air cooled to 1200 deg., heated to 1400 deg. for one hr., cooled to 1000 deg., and kept there for one hour before being finally cooled. This sequence of treatment is carried out in gas-fired, roller rail-type continuous furnaces, and the resulting structure consists of rosettes of temper

per cent Ni, the remainder being Fe. This is probably the only alloy in existence which resists the corrosive action of hydrochloric acid at all concentrations and temperatures, and this resistance is attributed to a protective compound film which forms on the surface after a definite period of exposure. This alloy was developed accidentally during experiments to the end of improving the properties of Duriron.

While on the subject of corrosion resistance, mention should be made of a new German stainless steel called Roneusil, which has a "warm" color, compared with the "coldness" of ordinary stainless. It has been said that commercial stainless steels "lack the pleasing luster of silver and, even though the difference is subtle, many per-

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answer research has yet given to certain exacting demands of industry. The prime function of columbium is to control the carbide constituents of chromium steels. There have long existed many possible applications in which plain chromium steel would have proved exceedingly useful had its air-hardening characteristics been modified or eliminated. Columbium is very effective in overcoming or modifying the air-hardening properties of these steels, including those of the high-chromium stainless type. In the past year columbium-bearing chromium steels have aroused much interest and favorable comment,

nickel. This corrosion-resistant alloy is heat-treated after fabrication and is used in airplane construction. Such an airplane is shown in Fig. 2.

Still new to many is the 18-8 type of chromium-manganese steel which, however, has been successfully used in a limited number of applications for several years.

The analyses of many heat-resistant steels containing 20 to 35 per cent chromium have also been modified. A new alloy containing 35 per cent chromium and 7 per cent aluminum has recently been announced as suitable for continuous service at 2300 deg. F.

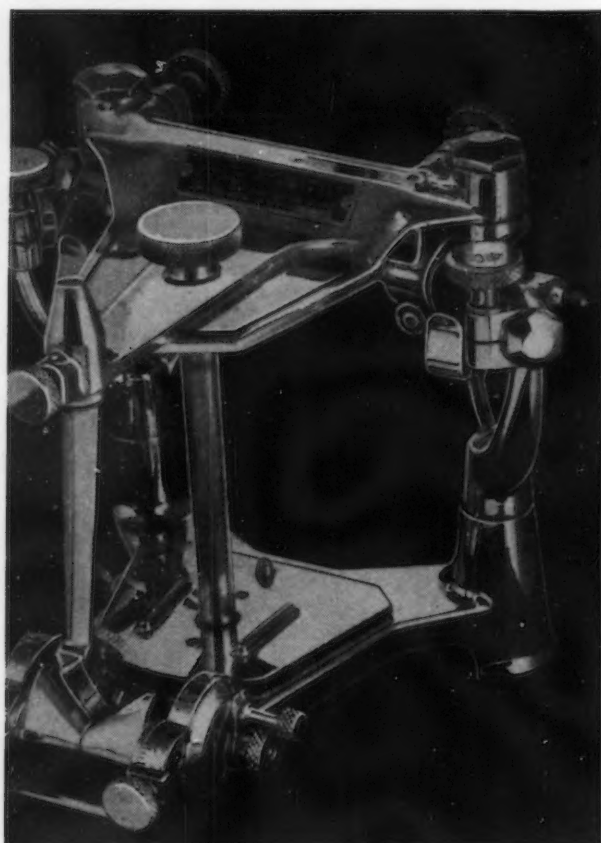


FIG. 4  
**ASSEMBLED** dental machine. Each part was die cast from zinc alloy. Machining each part individually and graduating the scales would be an expensive procedure.

especially among those who are interested in products fabricated by welding. Columbium is used in 18-8 chromium-nickel stainless steel welding rods, and either columbium or titanium in the stainless base metal to inhibit any tendency toward intergranular corrosion that might otherwise be present in or near welds.

Among the important modifications of the straight chromium, oxidation-resistant steels, is a new heat-treatable alloy containing 16 per cent chromium and 1 per cent

Another important modification of the high-chromium steels with which steelmakers and foundrymen are becoming familiar is the addition of nitrogen to improve the grain structure. Steel castings containing over 20 per cent chromium have been in use for many years in applications where resistance to corrosion, to high temperatures, and to excessive wear is desirable. Such castings have shown a tendency toward the formation of a large grain structure and toward grain growth when

held at a high temperature for very long periods. The addition of nitrogen to such alloys has the effect not only of reducing the tendency to grain growth at high temperatures, but also of refining the grain. This results in a marked increase in the ultimate strength, yield point, elongation, and reduction of area. The nitrogen is added in the proportion of approximately one part of nitrogen to 120 parts of chromium. It is introduced in the form of high-nitrogen ferrochrome. The influence of nitrogen on the microstructure is shown in Fig. 1.

Nitrogen is added to chromium steel ingots as well as to castings, and imparts a fine grain to the metal. The fine grain makes the alloy tough, ductile and more adaptable to deep drawing operations. Nitrogen-gearing high-chromium steel therefore appears to have valuable potentialities for manufacturers desiring a high quality corrosion-resistant seamless tubing.

Another stainless metal, an intermediate alloy or 9 per cent chromium steel, was given some final development work in this country during the year. The composition specified is 0.15 maximum C, 0.50 maximum Mn, 0.50 maximum Si, 8.0 to 10.0 Cr and 1.25 to 1.75 Mo, and the steel is excellently suited to moderately severe corrosive and oxidizing service up to about 1250 deg. F. Tubes of this alloy will show physical properties over 75,000 lb. per sq. in. tensile strength, yield point of 30,000 lb. per sq. in., 30 per cent elongation in 2 in., and a maximum Brinell hardness of 180. The creep properties are on the order of 0.10 per cent in 1000 hr. at a tension of 2300 lb. per sq. in. at 1200 deg. F.

From the U.S.S.R. comes the report that stainless steels can be cheapened by replacing all or most of the nickel present with manganese. Good results were obtained with a steel containing 18 per cent Cr, 8 Mn, 1 Cu and 0.1 C. Quenched from 1922 deg. F., it is composed of 60 per cent austenite and 40 per cent chromium-bearing ferrite. This two-phase steel can be more easily rolled and drawn than straight austenitic steels. It has good physical properties, good machining characteristics, it is said to be cleaner than the usual 18 and 8 grade and can be welded more easily. It has some inter-

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granular corrosion properties and cannot be stabilized by the addition of carbide forming elements. In moist hot atmospheres, it is reported as having better corrosion resistance than any stainless steel with the exception of 18 per cent Cr, 6 Mn, 4 Ni and 1 Cu steel.

Passing from stainless steel to the more widely used carbon grades, the evidence is that much of the work of the past year has

metal has no sharp yield point in the temper-rolled condition. It is said to be superior in resistance to cracking in some very severe drawing operations, and the company claims it will retain these initial excellent drawing properties indefinitely.

In the general run of mild-steel sheets, a sharp yield point develops within a comparatively short time after cold-rolling, depending upon

obtained after heavy cold rolling and low-temperature annealing approach those obtained by full annealing. The evidence seemed to indicate clearly that, when complete recrystallization occurs with low-temperature annealing after heavy cold rolling, the tensile properties show that the drawing qualities should be about the same as those obtained by annealing at, say, 1742 deg. F. It was not possible to prove by actual drawing operations that this was the case.

All the foregoing shows that 1936 was an active year for the development of ferrous alloys of improved properties to be used in both generalized and closely defined applications. The record for new non-ferrous alloys and extended application of older alloys was equally spectacular. In this latter field, die cast non-ferrous alloys occupied the most prominent position. The sale of high-purity zinc for use in die casting zinc alloys in 1936 jumped 30 per cent over the 1935 figure. Demands for weight reduction, permanence of dimensions and properties and resistance to corrosive attack were satisfied to a greater degree in 1936 by aluminum alloy die castings. The general public became specifically conscious of magnesium alloy castings for the first time through its application in the Hoover vacuum cleaner, and technique for the casting of magnesium-alloy products such as typewriter cover plates, portable tool castings and small parts for aircraft engines was greatly improved.

Because of its preeminent position as the largest volume outlet for die castings, the developments of the twelve months in zinc alloys will be considered first.

### Zinc Alloy Die Castings

The year's new applications of zinc alloy die castings were for the most part due to a general realization of the sizable savings in costs and the new freedom in design enjoyed by other manufacturers in other fields through the use of die castings, and did not represent castings of unusual interest as regards their production. However, several noteworthy parts and pieces, heretofore made by other methods, became zinc alloy die cast parts and pieces in 1936 because of recent improvements in machines and practices. An interesting example is offered by the

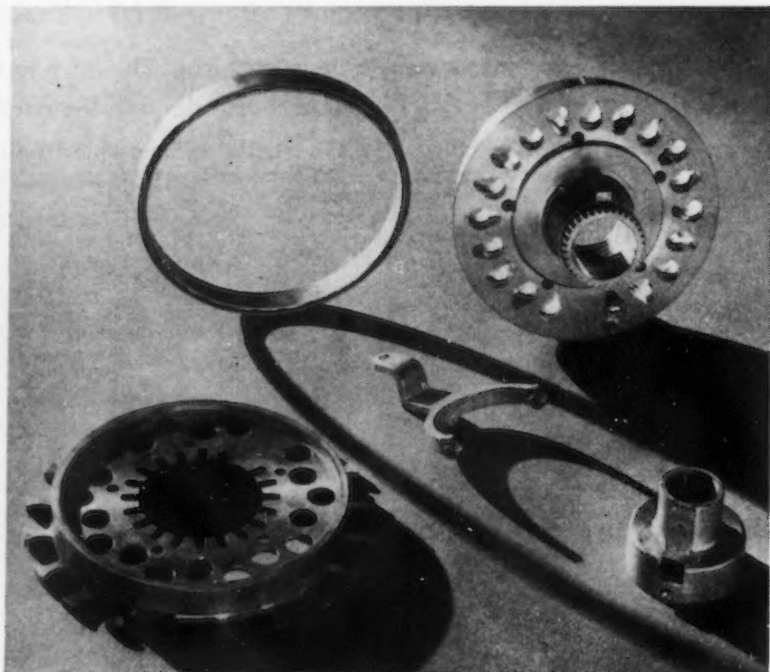


FIG. 5

**Z**INC alloy die cast Philco automatic tuner. Note the minute detail in this complex casting.

been directed toward giving the automobile maker a more satisfactory cold-rolled sheet. One problem, aging, is now giving less trouble than it was several years ago, but it is still a characteristic which requires considerable research to be overcome completely. Although all steel companies are offering sheets for which the aging is very low, the American Rolling Mill Co. is one of the few makers to sell a deep-drawing sheet guaranteed against deterioration. Armco's new "stabilized steel" is a non-aging cold-rolled steel with all stretcher strain permanently eliminated, in the tempered condition. It is said to retain indefinitely all the properties of temper-rolled steel, making pre-fabrication treatments unnecessary, regardless of the length of time the metal has been in stock.

Unlike ordinary mild steels for deep-drawing purposes, the new

the aging temperatures to which they are subjected. It is generally found that at 212 deg. F. the "yield-point elongation" increases continuously and reaches a maximum after about two weeks at this temperature.

Another investigation of the year directed toward improving auto-body sheets dealt with the effect of varying degrees of cold rolling and of annealing temperatures on the properties of this class of material. The experimental work was done by C. A. Edwards, D. L. Phillips and C. R. Pipe, and the report was presented before the American Iron and Steel Institute. This experimental work represents a preliminary attempt to correlate the effects of cold rolling and annealing, the tensile properties and crystal structure with the Erichsen values, and, further, to ascertain whether the tensile properties



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stem guard of the Ingersoll Waterbury pocket watch, a tiny part now die cast in zinc alloy and made possible by the development of new small automatic die casting machines capable of making as many as 1000 "shots" per hr. The casting precision possible for a part this small is shown in Fig. 3. Even in the domain of large and medium size die casting machines, production rates have been stepped

plications, such as in ornamental hardware, this property is not important, but, since the strength and castability of the stable alloys have been so noticeably bettered by improved alloying and die casting techniques, there is little advantage remaining in favor of other types of alloys. Also, in zinc alloy die castings the possibility of porosity, sometimes found in old-time castings, has been largely

to openings in the cradle casting. No machining is required; the two parts fit in perfect sliding contact—as cast. A second manufacturer also has just developed a new design of domestic oil burner which is entirely housed within a die cast casing—motor, fan, mechanisms, et al.

Still another new field for die cast non-ferrous alloys is offered by the modern movement toward the use of parking meters. Over 10,000 such devices have been produced to date, and all three of the types made have a case, complex interior mechanisms and exterior hardware die cast of zinc alloys.

Parking meters suggest another application that is rapidly growing. Vending machines, dispensing peanuts, cigarettes, phonograph music, and gum in return for small change, are largely turning to die cast parts because of their lower cost, the complexity of form they may take, and the machining, assembling and finishing operations they eliminate. The latest Stewart and McGuire peanut vending apparatus is composed almost entirely of die cast parts. Photographs of this attractive unit may be found in H. R. Simonds' article farther on in this issue. In these photographs note that the frame, the case, the doors, the knobs, the coin ways, the ratchets, and the decorative elements, all are produced from zinc alloy die castings.

Even scientific instrument makers are looking toward die castings, a tendency notable because it demonstrates that tremendous productions of each part are no longer always necessary to realize the economies of die casting. Often relatively simple, and therefore inexpensive, dies may be used to do a task with die casting which would otherwise be difficult. One dental instrument, a precision job, which duplicates the measurements and relative movements of the patient's jaw, is composed almost exclusively of 31 zinc alloy die cast parts. These castings are shown in Fig. 4. Machined in other materials, the skilled labor required to produce these pieces would be a sizable item.

Commercial zinc alloy die castings are far better than ever today from standpoints of physical properties and aging characteristics. Gradual improvements in these directions have been largely respon-

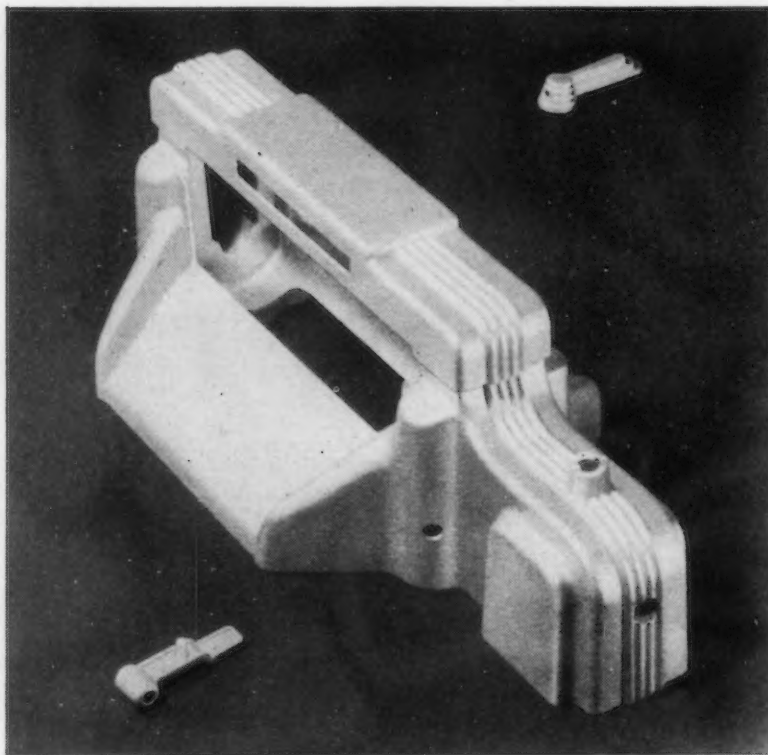


FIG. 6

**D**IE cast aluminum wringer frame weighing 6 lb. and having overall dimensions of 22x11x7½ in. Aluminum is successfully die cast commercially for parts measuring 50 in. in one dimension and weighing as much as 19 lb.

up this year. In certain cases, sizable castings may be produced at a rate of 500 "shots" per hr.—100 "shots" an hr. constituted a high rate a year or two ago. Correspondingly, larger machines are now being made. One machine now accommodates a die 48x48 in. in face size.

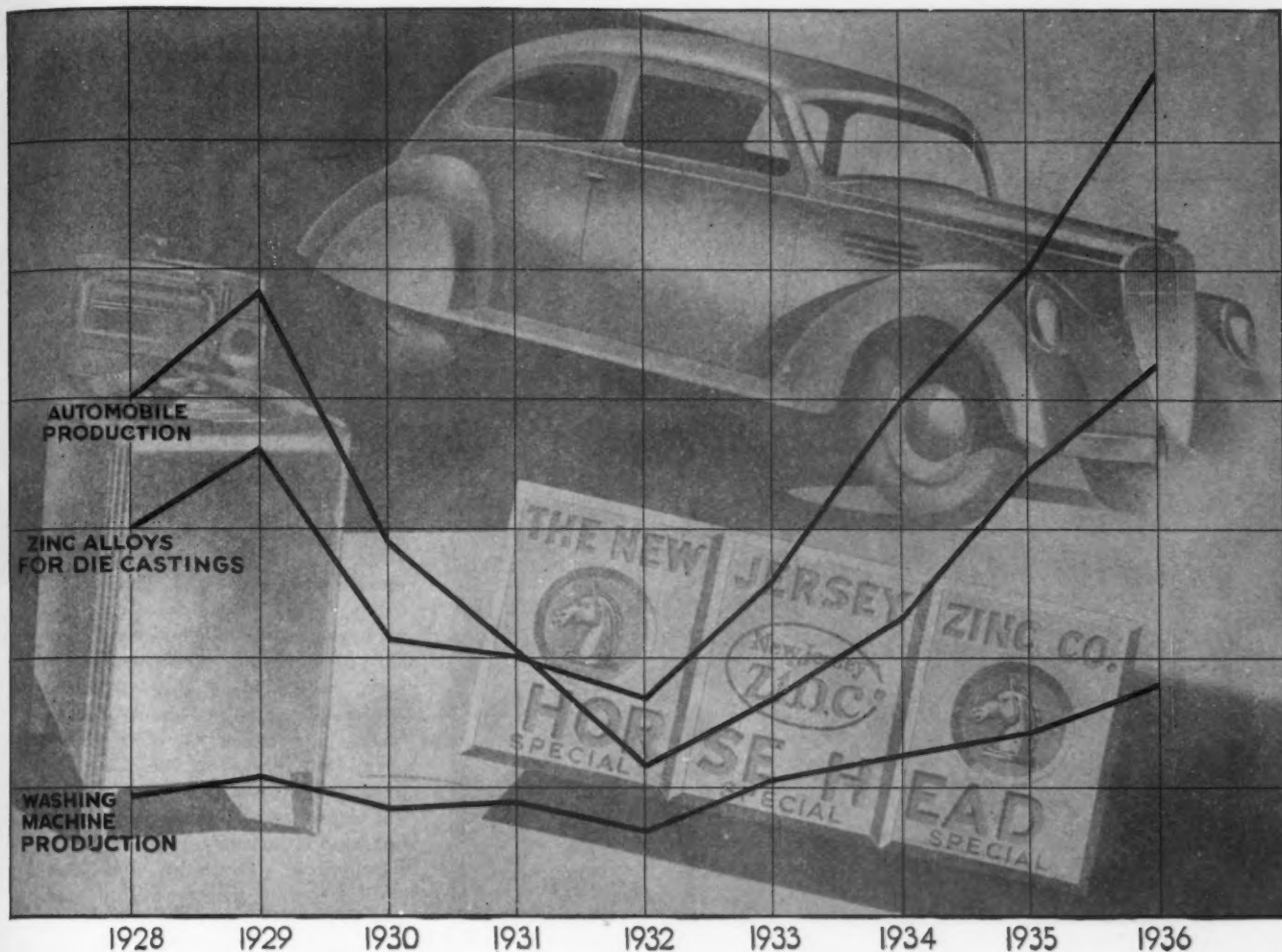
Among other recent trends in zinc alloy die casting art are several which pertain to the quality and characteristics of the castings themselves rather than to their applications. There seems to be an increased preference among die-casters for the stable type of alloy—that type which is so constituted metallurgically or so treated after casting that no dimensional changes, however small, occur in parts during service. In many ap-

eliminated as the result of greater knowledge of die design. Considerable has been added in 1936 to the industry's store of knowledge concerning the gating, venting, temperature control, coring, and overflowing of dies.

In 1936, zinc alloy die castings appeared as large and vital elements of home heating oil burners. In the new Bethlehem Doe model the complete mechanical unit of the product is assembled on a die cast main cradle. To this main cradle the driving motor and the oil pump are attached, and within this cradle the burner fan revolves. Fitting snugly on the cradle is the cylindrical inlet air shutter, also zinc alloy die cast, which regulates air input to the finest of degrees by its movement relative

The Research was done, the Alloys were developed, and most Die Castings are specified with

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## THERE MUST BE A REASON!

Using for comparison the production figures of two of the largest consumers of ZINC Alloy Die Castings—automobiles and washing machines—we follow the production of ZINC Alloy for Die Castings from 1928 through 1936.

As the chart indicates, the ZINC Alloy production has curved up and away from these two major industries since 1932, and therein lies the ZINC Alloy Die Casting development story. A story of acceptance for small tools, business appliances, household items, novelties, toys, hardware, and hundreds of other applications which are inevitably ahead.

There must be a reason for this acceptance.

## THE NEW JERSEY ZINC COMPANY

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sible for the new use this year of die cast zinc alloys for such outstanding parts as the mechanism of the new Philco automatic tuning device, the Motorola auto radio control case, and the Dupont motion picture camera spool. In the photo of the Philco tuning device parts, shown in Fig. 5, note the minute detail of the tiny teeth fringing each egg-shaped hole in

zinc alloy die castings in 1937 automobile models, the reader is referred to the article by Herbert Chase in the Nov. 12, 1936, issue of THE IRON AGE.

One final development of the year in the domain of zinc alloy die casting is noteworthy—the Cronak dip treatment perfected in the Research Laboratories of the New Jersey Zinc Co. The film

parent golden-brown is deposited on the surface. The owners of the process have granted licenses rather broadly for the use of the treatment, and it is expected that, as a consequence, additional manufacturers, unable to use die castings in certain applications to date, will find it possible to enjoy the savings and conveniences of the zinc alloys with this new safeguard against white zinc salts.

### Aluminum Alloy Die Castings

Like the alloys of zinc, the alloys of aluminum had a very successful year, with total volume of castings produced in 1936 valued at approximately \$7,500,000. Since the aluminum die casting art first began to gather momentum in about 1915, there have been numerous changes in this field. The original plunger or piston type machine gave way before the pneumatic machines, and thus freezing of plungers was obviated. Carbon die steels, which were first used, were superseded by oil-hardening chrome-vanadium steels, which in turn gave way to air-hardening chrome-tungsten-molybdenum steels. The soldering effect of the aluminum alloys on the dies was greatly reduced by these changes. An improved technique of die coating and lubrication, greater experience in die design and location of cooling water channels was developed, and the early aluminum-copper alloys were ultimately displaced entirely by silicon-bearing combinations.

The aluminum alloys now in general use for die castings, listed in Table I, show the presence of silicon in every case. The silicon is extremely beneficial, since it adds greatly to fluidity and thus aids in the production of thin-wall castings. Alloy No. V is used extensively for large, thin-wall and intricate castings, and it has the advantage of excellent resistance to corrosion. This alloy is giving good service in the form of unprotected outdoor electrical meter cases and connection boxes. Instrument cases, washing machine wringer frames, and vacuum cleaner nozzles are other sizable parts cast in an aluminum-silicon alloy. Parts requiring maximum ductility combined with best resistance to corrosion may be cast in No. IV alloy. The aluminum-copper-silicon alloys cover the majority of small parts and offer a

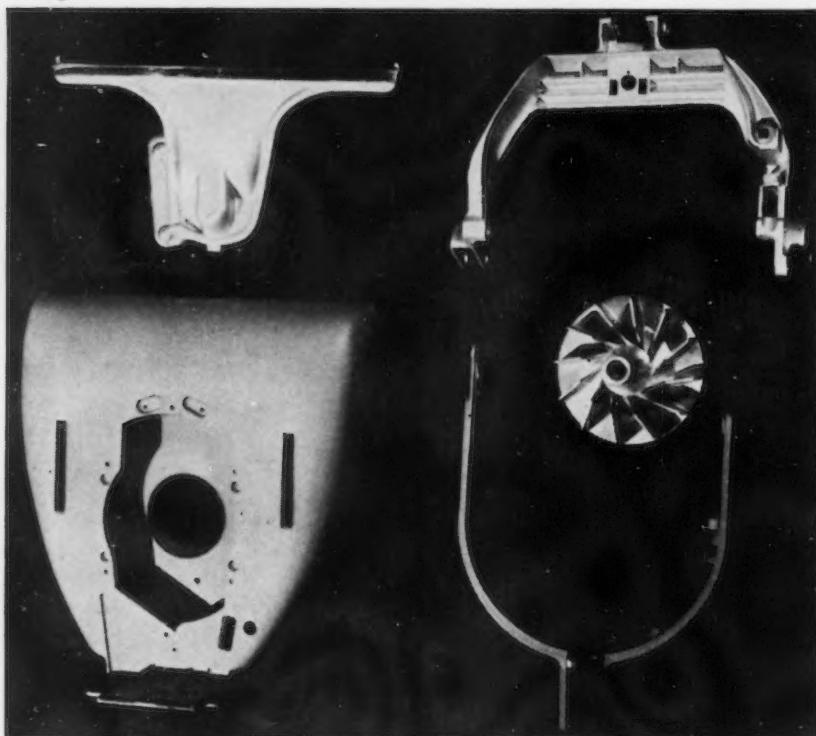


FIG. 7

THE most publicized die castings of 1936, the major parts of the Hoover model 150 vacuum cleaner, die cast of Dowmetal for the first time. This achievement not only is an excellent example of the die casters art but also proves that magnesium alloys can be used for large and complicated parts, all the while having good definition of detail and excellent surface finish.

the upper-right piece, the notched groove on the end face of the upper-left ring, and the complicated perforating of the lower-left plate. Were it not for the zinc alloys and up-to-date die casting technique, it is possible that the ingenious Philco automatic tuner would never have been commercially feasible.

While the die casting of automobile radiator grilles is not new, the designs for 1937 are new, and as these parts are among the largest and most striking of die castings, it is not amiss to mention them. The 1936 Oldsmobile "6" grille is an example of exceptional design in large die castings—artistically as well as mechanically. For further data as to the use of

deposited by the process has the property of inhibiting any surface corrosion of zinc, and is particularly valuable where white salts, formed through entrapped moisture, severe outside exposure, or contact with salty atmospheres or materials, are likely to be objectionable. Automobile carburetor, door lock, and vending machine makers are already employing the treatment to fine advantage. The Cronak film has also been found useful as an undercoat for low bake enamels. By the process, finished zinc alloy die castings or other zinc products are dipped for a few seconds in a simple patented chemical bath, rinsed and dried under an air blast, with the result that a thin, tight skin of trans-



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range of physical properties from the higher ductility of No. VI to the best combination of strength, ductility and impact strength of No. VII. Alloys containing nickel have an attractive color and lend themselves to polishing and plating.

The production of large parts was hardly conceived of in the early years of the industry. But sizes grew steadily nonetheless, and in 1936 a leading manufacturer of pyrometric equipment received potentiometer cases measuring 20 x 19 x 12 in. and weighing 19 lb., a saving of several pounds in

comparison with the weight of the part as produced by a competitive fabricating process. The case is cast in a die 4 ft. in length, approximately 30 in. square. Metal is shot into the die impression simultaneously through two sprues at diagonally opposite corners of the square base. Die operation is complicated by undercuts to cast door hinges, so that two loose cores must be ejected with the casting and then removed.

Double feeding has also been used to advantage in casting washing machine wringer frames. One frame, shown in Fig. 6, with over-

all dimensions of 22 x 11 x 7½ in., is cast with bearing seats and a gear box, thus reducing the number of parts for assembly. Wall sections are remarkably thin for a casting of such extended surface. The part weighs less than 6 lb., and yet loading tests have demonstrated that the frame has ample strength to perform the service allotted it.

To the preceding examples may be added the multitude of parts for which the aluminum die-casting industry has become a standard source of supply. Die-cast parts for outboard motors, including steering gear assemblies, flywheel covers, crankcases, gear housings, propellers and other castings, have enabled the manufacturers to reduce weight, machining and assembly costs and hence to put a better motor on the market at a lower cost. Typewriters, adding machines, mimeograph and teletype machines are using an increasing number of die-cast aluminum parts in response to a demand for weight reduction. The aircraft industry depends to a limited extent on aluminum alloy die castings for weight reduction in such parts as radio shields, rocker box covers, spark plug coolers, and various engine fittings.

The industry has an interest in automatic casting machines for speeding up production. There are, however, certain operations having to do with care of the dies, which seem, for the near future at least, to limit completely automatic set-ups to comparatively simple castings. The production of good aluminum die castings depends to an appreciable extent on technique of operation, and it probably will be many years before the human element is eliminated.

#### Magnesium Alloy Die Castings

Since the first commercial production of magnesium 20 years ago, there has been performed much arduous development work in enabling pure magnesium to be as freely available as it is today. Of the many attempts to extract the base metal, magnesium, from its natural sources, the "chloride process" as perfected and operated by the Dow Chemical Co., Midland, Mich., survives as the most economical and practical method and accounts for the present production of the metal in this country.

The source of the magnesium as well as many others of the three



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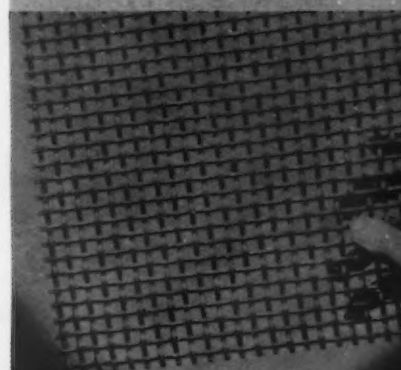
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hundred products of this company is a natural brine occurring at a depth of 1200 to 1400 ft. This is pumped into the plant from more than a hundred wells scattered for 30 miles across central Michigan. The brine contains approximately 0.8 per cent of magnesium as magnesium chloride, which is separated from the other salts in the brine and carefully dried to a substantially anhydrous condition. It is then fused and electrolyzed to secure the magnesium metal which floats in a molten condition on the cell bath, from which it is skimmed at intervals and poured directly into ingots. The ingot metal analyzes 99.9 per cent pure magnesium, and is sold extensively in this form throughout the world.

Magnesium alloy die castings were first produced commercially in a small way about 5 years ago. The pure metal must be alloyed to give it strength for the wide variety of structural applications now making use of this material. Alloys and fabrication processes are now available for the production of sand and die castings, forgings, rolled sheet, and extruded structural sections. The most conspicuous die casting of 1936

was the cover and essential parts of the Hoover vacuum cleaner made for the first time of magnesium alloy. A glance at Fig. 7 will show that magnesium can be cast in large and complicated parts, all with good definition and surface finish.

The equipment available 5 years ago proved inadequate for die casting of magnesium, necessitating the development of machines especially for this use. While this development is still going on, it has reached the point where the large scale die casting of magnesium alloys has become a practical proposition. The goose-neck type of machine has been virtually abandoned in favor of the well and plunger type, by means of which pressures as high as 5000 lb. per sq. in. are applied to the molten metal. The recent machines are fully hydraulic and are heavily constructed to withstand the very considerable loads resulting from the high metal pressures used. The castings are much smoother and sounder than the usual die castings made by low pressure machines. A photograph of a recent improved machine is shown in Fig. 8.

The tolerances for magnesium die castings are, in general, the same as for aluminum castings; in fact, the dies usually are interchangeable, although larger fillets and the rounding off of sharp corners are advantageous. Gating design and the machine operating conditions must, of course, be worked out for each casting.

The alloy which has found the widest application is of the following nominal composition: 10.0 per cent aluminum, 0.1 per cent manganese, 0.5 per cent silicon, and the balance of magnesium. A.S.T.M. standard die cast test bars of this alloy have approximately the following properties: 28,000 lb. per sq. in. tensile strength, 21,000 lb. per sq. in. yield strength, 1.0 per cent elongation in 2 in., and 1.0 ft. lb. impact strength.

#### Brass Die Castings

As in the case of zinc, aluminum and magnesium, the year was extremely successful for die casters of brass, the volume of business done in 1936 being probably of the order of twice that booked in 1935.

During the year two new ma-

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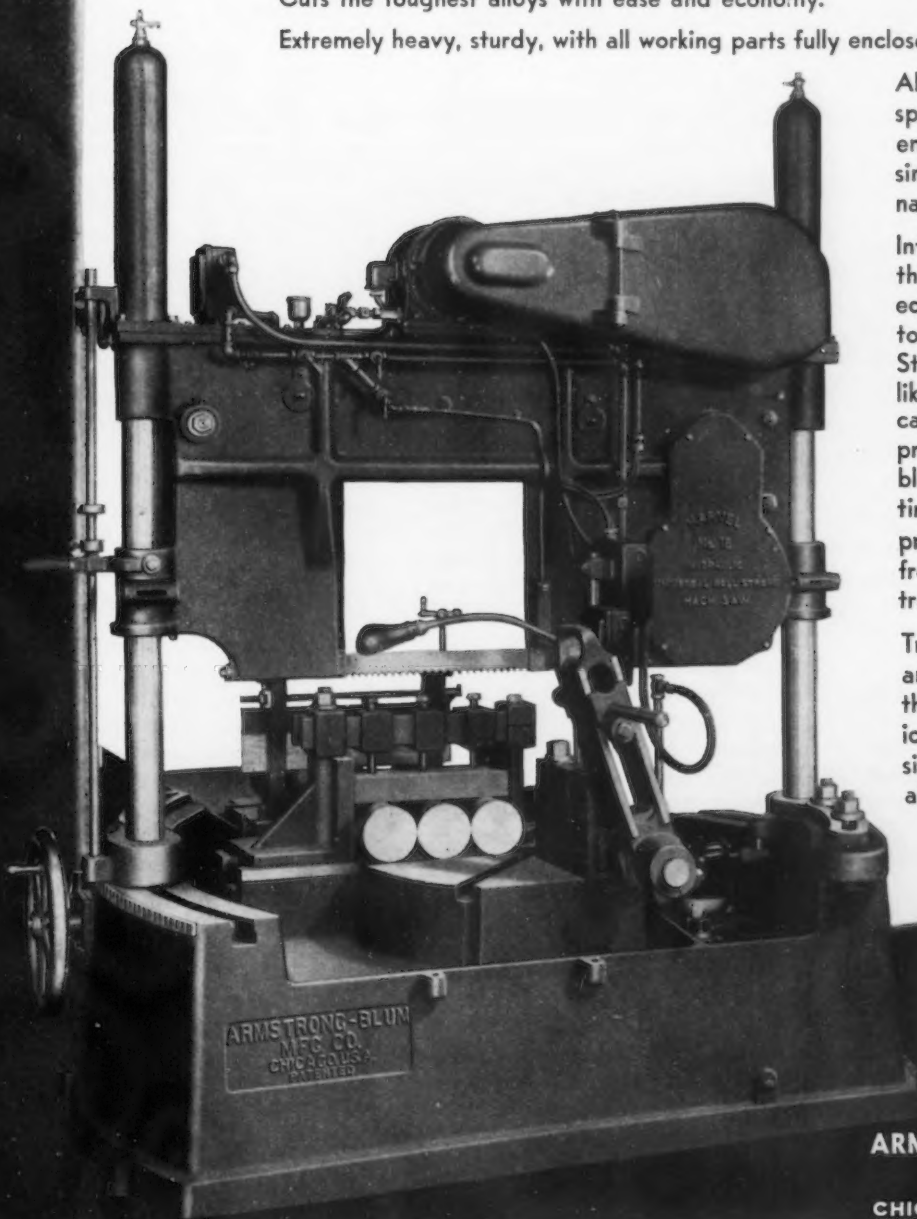
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## Do YOU know the Answers?

Count 20 points each for the correct answers to the following questions. Can you score 80? Don't look now, but the answers are on page 626.

1. A baseball infield is laid out in the shape of a:
 

Rhombus	Square
Diamond	Helix
2. Of course, you should know that Pelota is:
  - An Indianapolis race driver
  - A French-Basque sport
  - A South American beast of burden
  - A noted Italian statesman
3. You could wear one of these:
  - A South American bolero
  - An African bamboula
  - A Spanish serape
  - A Welsh corgi
4. The name "Kitty Hawk" is associated with:
  - The development of aviation
  - The early days of motion pictures
  - A celebrated divorce case
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chines of American manufacture were offered to the industry for the production of brass pressure die castings. One of these machines is built by the Reed Prentice Co. and the other is built by the Madison-Kipp Co., the latter being constructed under license arrangement with Josef Polak, Prague, Czechoslovakia. Although this machine's features generally follow the European machine, there have been introduced several novel features.

The machine built by the Reed Prentice Co. is adapted to large parts and is of rugged four tie-rod construction. Three of these machines have been sold, one going to a large manufacturer of plumbing fixtures.

There has been little or no change in the metal composition, temperature control, design, size or treatment of castings during 1936. However, the life of dies is still not what it should be. The question which will eventually prove whether this process is to be economic is the problem of securing a grade of steel which will stand up under the punishment to which this process subjects the steel dies.

It should be pointed out that the mechanical engineers have developed a machine which will economically produce die cast brass, but the steel metallurgist has not kept pace with the engineer who

has made this process feasible. This is an unfortunate circumstance which confronts not only the manufacturer who is using the process but the customer who would like to make use of the process, but is turned down because die-life expense makes the particular type of casting desired uneconomical.

### Other Non-Ferrous Alloys

Of the numerous non-ferrous experiments reported during the year, lack of space precludes mentioning all but a few. For the bronze foundries, mention should be made of a new hard bronze reported by Cuive et Laiton (France). The analysis mentioned was 82 to 84 per cent copper, 3.5 to 4.5 iron, 2.5 to 3.0 nickel, 0.7 to 1.0 manganese and 10.0 to 11.0 per cent aluminum. The metal has a Brinell hardness of the order of 170, a tensile strength of 85,000 lb. per sq. in. and an elongation of 10 to 14 per cent.

In England, the non-ferrous sub-committee of the Institute of British Foundrymen during the year released recommendations for two leaded gunmetals. In the past, a lack of standard specifications has made it necessary for foundries to make gunmetal to conform to the desires of individual customers when the desired alloy differs from Admiralty gunmetal. For Admiralty metal, the institute has

drawn up an individual specification.

In the preliminary survey conducted by the sub-committee 37 specifications were found to be in use, the major constituents of which were within the range of 82 to 93 copper, 4 to 9 tin, 0 to 7 lead and 1 to 8 zinc. The sub-committee came to the conclusion that it would be to the advantage of both producer and consumer if a few compositions were to be accepted as standard which would adequately cover the field now represented by the 37 specifications. The two alloys recommended to cover the field have the following compositions:

87:9:3:1 gunmetal—8 per cent minimum tin, 4 maximum zinc, 2 maximum lead and the remainder copper.

85:5:5:5 gunmetal—5 per cent minimum tin, 6 maximum zinc, 6 maximum lead and the remainder copper.

A number of test bars of these alloys, using green and dry sand or both and casting at 2012 deg., 2134 deg. and 2192 deg. F., were made in various foundries and physical data obtained were reported for maximum stress, elongation, Brinell hardness and density. These data may be obtained from the institute.

A detailed investigation on the casting of German silvers was undertaken late in the year in France. This type of alloy in America usually contains 20 per cent nickel and 5 per cent zinc, while in Europe the zinc content is usually 12 to 30 per cent. It was found most important, in order to obtain a sound casting without gas inclusions, to add an easily oxidizing metal which eliminates the gas. Mg, Mn, Al, and Si were reported as giving good results. It was stated, however, that Al and Mg in excess make the metal viscous. Mn avoids this inconvenience but is less active than Al. Good results were obtained with 0.3 to 0.5 Mn, added as cupro-manganese (30 per cent Mn), or metallic Mn. Aluminum as metal or cupro-aluminum should be added in an amount of 0.02 to 0.03 per cent. Addition of 0.3 Mn, followed by an addition of 0.015 Al as cupro-aluminum (50 per cent Al) or even 10 to 15 per cent Al was particularly recommended. It was stated that the additions should be made when the pouring temperature has been attained but by no means before. Pouring tem-



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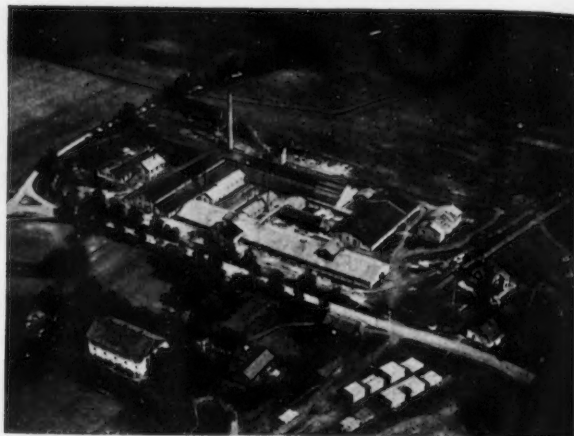
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perature should be no less than 2282 deg. F., and for low zinc contents at least 2462 deg. Molding sands should be more refractory than for usual foundry purposes, and if the castings are used for decorative purposes, without machining, a fairly fine-grained sand should be used.

The report stated that in order to accelerate cooling and avoid porosity it is advisable to mix 3 to 5 per cent graphite with the sand to increase its thermal conductivity. Molds and cores should be carefully baked; a sand consisting of 80 per cent siliceous and 20 per cent yellow sand, agglomerated with linseed oil and dextrine was stated as being particularly suitable in this case.

### Special Bronzes

An important study of the properties of some special bronzes was conducted by D. Hanson and M. A. Wheeler of the British Institute of Metals during the year. In examining these bronzes, which contained 3 to 10 per cent tin and 1 to 7 per cent aluminum, usual difficulties were had in obtaining

ingots free from surface blemishes by the trapped oxide skin. The method finally adopted was to tilt the mold, and to pour the stream of metal down the narrow edge. In this way the defects were mainly confined to this edge, and their effects could be estimated.

Rolling properties were investigated by noting the degree of reduction before the characteristic shear cracks formed at the edges. All of the alloys were successfully rolled after annealing for 12 hr. at 1350 deg. F., reduced 50 per cent cold, reheated 1 hr. to 1300 deg. F., and cold rolled to a total of 80 per cent of the original. Hot rolling after annealing for 14 hr. at 1400

deg. F. was easily done on all alloys, which were converted to a solid solution alloy by this heat treatment.

Annealed alloys possess very good ductility; the maximum tensile strength attained was 67,000 lb. per sq. in. in one with 4 per cent aluminum and 5 per cent tin.

The original surfaces of the "as cast" ingots containing more than 2 per cent aluminum, were comparatively resistant to scaling up to temperatures of 1500 deg. F. If, however, the cast surface was machined, it was found that all the alloys formed a dark colored oxide at 600 to 800 deg. F., the temperature of formation increasing with the aluminum content. In a normal 10 per cent tin bronze, the scale which formed at high temperatures rapidly thickened and was easily detached, but when aluminum was added the thickness of the oxide scale diminished and it became very adherent.

The scales formed on these alloys were difficult to remove by pickling; immersion for 2 hr. in 20 per cent HCl, 20 per cent HCl

TABLE I Most Common Aluminum Alloys Used for Die Castings				
A.S.T.M.	Composition			
Alloy No.	Copper	Silicon	Nickel	Aluminum
IV....	..	5	..	balance
V....	..	12	..	balance
VI....	2	3	..	balance
VII....	4	5	..	balance
VIII....	1.5	4	2.25	balance
IX....	4	1.75	4	balance
XII....	8	1.5	..	balance



**1850      -      1937**

**Lake Superior  
Iron Ore**

•

**Vessel Transportation**

•

**Coal  
For All Purposes**

**THE CLEVELAND-CLIFFS IRON CO.**

UNION TRUST BLDG.



CLEVELAND, OHIO

plus 10 per cent  $H_2SO_4$ , 10 per cent and 20 per cent  $H_2SO_4$ , or 20 per cent  $HNO_3$  has practically no effect. Scale may be removed from annealed alloys by emery cloth. A reddish intermediate layer must be removed, as it not only gives the alloy a patchy appearance, but tarnishes rapidly in atmospheric air, whereas the true alloy underneath is relatively resistant to discoloration in the air.

containing 3 per cent or more manganese and 5 per cent or more of tin. In general, the addition of a small amount of aluminum is beneficial.

To study the effect of higher aluminum, combinations of 2 and 3 per cent aluminum and manganese added to alloys containing 5 and 6 per cent tin were chosen, making eight alloys in all.

Since all showed a severely cored

the powder of another metal, has been the subject of considerable study, notably in France by J. Lassus. This work was extended during the year to the cementation of iron and steel by technically pure (90 per cent) beryllium and by ferro-beryllium (80 per cent beryllium), used in the form of 100-mesh powder, and the results were described in a paper in *Revue de Métallurgie*.

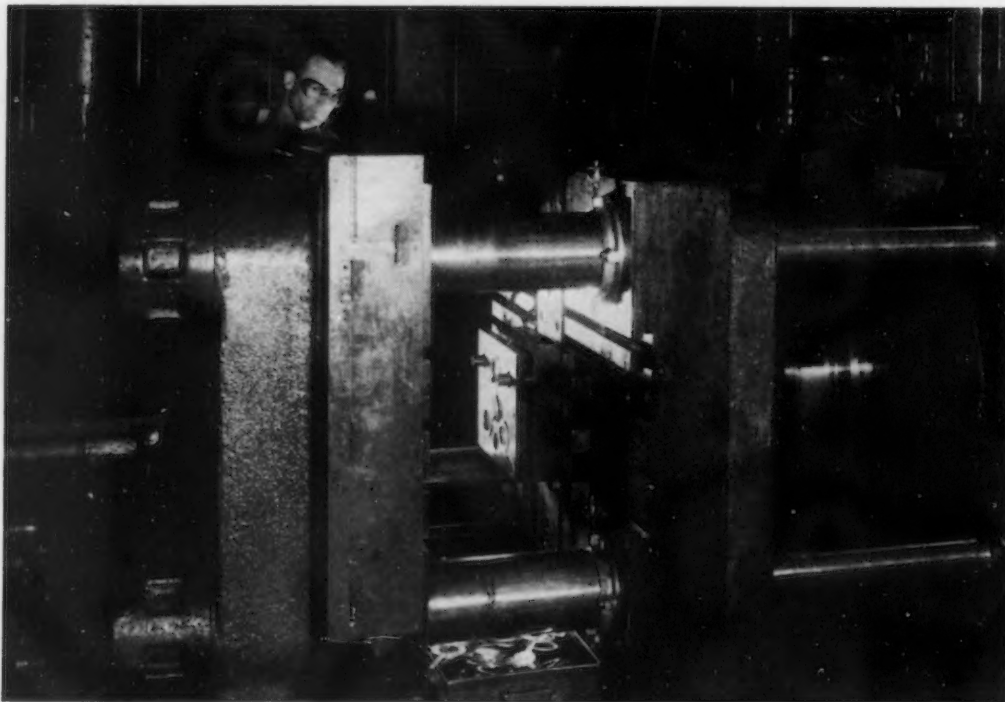


FIG. 8—New machine developed by Dow Chemical Co. for the die casting of magnesium alloys.

Up to 4 per cent manganese has a relatively small influence on the working properties of a 5 per cent tin bronze. As much as 6 per cent of manganese must be added before an appreciable embrittling effect is apparent. Alloys within the range of composition investigated can be worked hot or cold. Manganese increases the softening temperature of the tin bronzes.

When manganese and aluminum were both added to bronzes (the aluminum being in quantity up to 0.5 per cent, primarily as a deoxidizer), the ingots were generally cleaner and cast slightly better. The formation of a black oxide skin is rapidly suppressed as the aluminum content approaches 0.5 per cent, particularly with the higher percentages of manganese. If aluminum is used as a deoxidizer, not more than 0.25 per cent may be added without reducing the cold rolling properties of any alloy

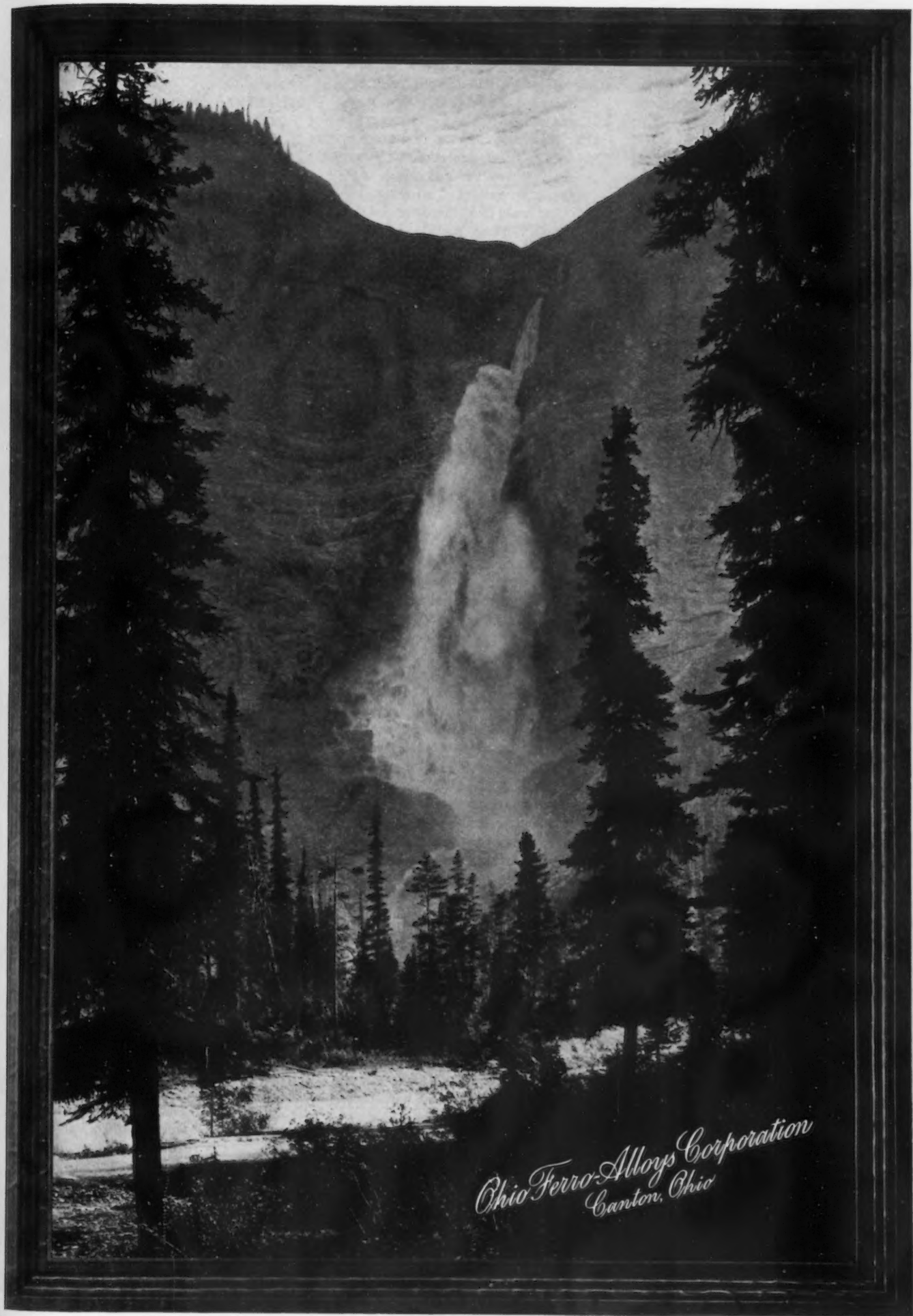
alpha matrix, in which the hard eutectoid had separated on cooling, there would be little hope of cold rolling these in the "as cast" condition. Consequently the alloys were annealed for 5 hr. at 1500 deg. F. (1 hr. to reach temperature), and slowly cooled in the furnace. All were cold rolled successfully after this treatment, those containing the higher percentages of alloying elements breaking down at a slightly earlier stage than the others, though all withstood a reduction of 70 per cent before signs of cracking appeared.

Aluminum was found to increase the tensile strength of manganese-tin bronzes, without appreciably reducing the ductility.

#### Cementation of Ferrous Metals With Beryllium

Cementation, a process in which a surface alloy is formed by heating a solid metal part embedded in

One of the principal objects of this study was to demonstrate that by an examination of the progress of inter-solid diffusion, it is often possible to throw light on the constitution of the alloys so formed. To this end, microscopical examination was carried out on four materials, electrolytic iron, extra mild steel (0.12 per cent C), medium carbon steel (0.36 per cent C), and eutectoid carbon steel (0.90 per cent C)—after samples had been cemented for varying periods up to 10 hr. at 1472 deg. F., 1652 deg. F., 1832 deg. F. and 2012 deg. F. The results were considered to support the iron-beryllium diagram of Oesterheld rather than that of Wever and Muller, and to indicate that, while beryllium is soluble in iron, the solubility first increases and then falls as the temperature is raised. This effect is not modified by the presence of carbon. The general



*Ohio Ferro-Alloys Corporation*  
*Canton, Ohio*

progress of cementation was found to be much the same with pure beryllium as with ferro-beryllium, an interesting observation being the production of a decarburized zone in the carbon steels. The hardness, resistance to scaling at high temperatures, and corrosion resistance of the cemented specimens were studied. Characteristic hardness values are shown in Table II, those of the cemented eutectoid steels being particularly striking, exceeding those of nitrided steel surfaces, and being some of the highest ever recorded.

### Lead-Base Bearing Metals

On the general subject of lead-base bearing metals, an excellent report was given during the year in *Stahl und Eisen*. For the most part, the production of a satisfactory bearing metal consisting chiefly of lead has been sought by two methods. The hardening of lead by the addition of small amounts of heavy metals has not met with much success, but a complex alloy of this type is on the market under the name of Thermit metal containing 6.2 per cent tin, 15.65 per cent antimony, 75.0 per cent lead, 1.0 per cent copper, 1.0 per cent nickel, 0.07 per cent iron and 0.01 per cent bismuth. The second method has been the hardening of lead with alkali or alkaline-earth metals such as sodium magnesium and lithium, and the modern tin-free bearing metals are alloys of this type. The best known of these is Bahnmatal, with 98.47 per cent lead, 0.72 per cent calcium, 0.57 per cent sodium, 0.04 per cent silicon, and 0.2 per cent aluminum and sometimes a small amount of lithium. This alloy is protected by patents. On account of the alkali-metal content, such alloys have to be prepared with care, and old bearings cannot be remelted except under carefully-supervised conditions. On the general subject of bearing preparation, recent research has led to increasing care being taken with the finish of bearings and the properties of the shaft to be supported.

It has been found advantageous to finish white-metal linings with a diamond tool which smooths and consolidates the surface and materially increases the carrying power of the bearing. Similarly, the harder and smoother the shaft, the better the results, and case hardening or nitriding, with final grinding to a perfect finish, are

proving economical in prolonging bearing life. An alloy simpler than Bahnmatal is Union metal, consisting of lead with 0.2 per cent calcium and 1.5 per cent magnesium. It was stated in the German article that this alloy can be prepared by the user, and instructions were given for the production of uniform castings. An alloying bell must be used for the introduction of the alloying metals into the superheated lead, and the article gave a special form of bell designed for this purpose. By the use of Union metal a saving of 79 per cent of bearing costs compared with the use of tin-alloy bearings was said to be achieved. The hardness of Union metal is slightly below that of an 80 per cent tin alloy at ordinary temperatures, but as the temperature is raised to 302 deg. F., the former improves relatively, and at that temperature has a Brinell hardness number of 15, against 10.5 for the tin alloy.

### Mg-Zn and Mg-Al Alloys

The influence of heat treatment on the corrosion of magnesium-zinc and magnesium-aluminum alloys was first treated in detail late in 1935 by the two Japanese workers, T. Murakami and S. Morioka. Early in 1936 this information was reviewed and amplified by E. Söhnchen, who was closely identified with similar work on the corrosion of magnesium base light alloys in Germany. The magnesium-zinc alloys used in the German experiments contained from 2 to 7 per cent zinc and the magnesium-aluminum alloys from 4 to 11 per cent aluminum, and both series were tested in various conditions of heat treatment, annealed, and after appropriate solution and aging treatments. The corroding medium for the zinc alloys was N/10 NaCl and for the aluminum alloys N/100 NaCl. The amount of corrosion was determined by the loss in weight of the machined sand-cast test bars. Of the zinc alloys, that with 3 per cent zinc showed the smallest amount of attack in all conditions of heat treatment, and with more than this proportion of zinc the corrosion became much more rapid. In all of these alloys a well-marked maximum in the rate of corrosion was found after aging treatment at 446 deg. F. This was attributed to the finely-dispersed form of the constituent precipitated from solid solution at that temperature, and

the reduced corrosion at higher aging temperatures is the result of coagulation of the precipitated phase with a reduction in the number of local elements.

With alloys containing 4 and 6 per cent aluminum, no difference in the rate of corrosion was obtained after different heat treatments. With approximately 8 and 11 per cent aluminum, heat treatment was found to exert a considerable influence, and in these alloys a marked minimum in the corrosion rate was obtained after aging between 392 and 572 deg. F. It was ascertained that this minimum was associated with the precipitation of the hardening constituent in a very fine state of division, and it is suggested that the favorable effect of this structure is to set up a large number of local cells which soon cause the whole surface of the alloy to become anodically oxidized and therefore resistant to further attack. Such an oxide film was observed in the second day of the corrosion experiments. The anode of the local elements is the magnesium solid solution, and the cathode is the precipitated compound of magnesium and aluminum. In the aluminum alloys the influence of composition is irregular. In the cast condition the corrosion increases with the aluminum, but after quenching and aging the reverse is true. With more than 10 per cent aluminum, and suitable heat treatment, the corrosion resistance is superior even to that of the same alloy in the cast state.

An intensive study of aluminum-magnesium alloys was prepared by Pierre Vachet and reported during the year in *Revue de Métallurgie*. It was found that accurate space lattice determinations showed that annealing for 16 hr. retains in solution about 8 per cent magnesium. Drawing of the quenched alloys precipitated the excess of magnesium above 8 per cent in 2 hr. at 392 deg. F., but 24 hr. was required to bring it down to 4.5 per cent. Only alloys in the solid solubility range were investigated, though a low rate of diffusion almost always resulted in beta phase precipitation. Dilatometric investigation indicated a practical similarity between curves obtained with alloys containing more than 11 per cent magnesium and no manganese and 9 per cent magnesium with 0.5 per cent manga-

Reprinted from  
The Modern Hospital

It was the Summer of 1927. To do homage to Charles Lindbergh, a throng of the great and near-great was gathered in the banquet hall of a New York hotel. Toast upon toast, eulogy upon eulogy, were tendered the returned hero—the solo flier who had just conquered the Atlantic.

Almost unnoticed at the speaker's table sat another Charles . . . Charles Lawrance, President of Wright Aeronautical Corp., designer and builder of the Wright Whirlwind motor whose ceaseless beating had carried Lindbergh to Paris in 33 hours.

At length a friend at his side spoke to Lawrance. "Charley," he said, "what are you thinking as you sit here in the midst of this adulation of the man who did the flying? Why is there so little thought of you, who, with your years of work, gave him the motor that made his flight possible?"

Lawrance paused. Then in his succinct way he answered,

"Who ever heard the name of Paul Revere's horse?"



## The name of Paul Revere's horse was "DOBBIN"

...and he wasn't a blooded Arabian . . . just a plain work horse. Of course he never got the credit he deserved. You can't cut fame up into little pieces and pass it around to everybody who shared in the job. Most of us are only too

glad to do our part because it's the way we earn our oats and . . . well, we get a kick out of doing it right.

Perhaps you have a manufacturing problem that involves metallurgical research. Maybe you're creating a new machine, a whole new industry—or a better mouse-trap. In any case, you'll find the Revere Technical Advisory Service only too ready to work its head off in developing just the right copper alloy and helping your plant find the best way to fabricate it. And when the job is done, we won't ask to share the glory. That is one thing we got from Paul Revere's horse.

# Revere Copper and Brass

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TABLE II  
Hardness Values for Iron and Steel Cemented With Beryllium

	Not Cemented	Vickers Pyramid Hardness Number	
		Cemented at 1,832 Deg. F.	Cemented at 2,012 Deg. F.
Electrolytic Iron .....	138	268	318
0.12 per cent carbon steel.....	176	554	628
0.36 per cent carbon steel.....	201	733	642
0.90 per cent carbon steel.....	250	1,506	1,267

nese, both in a quenched and annealed state. Under these limits there were observed two anomalies

which could not be explained, unless they were allotropic transformations of beta phase. For alloys

containing less than 8 per cent magnesium, quenching and annealing treatments produced the same properties.

Heating of the cold-worked metal between 302 and 842 deg. F. softened it in 5 min. When the magnesium was above 8 per cent, there was a precipitation of beta phase after treatment reduced the ductility of the alloys. Aging following a quenching from 842 deg. F. did not occur when the magnesium was below 8 per cent. With magnesium above this content, aging did not take place at room temperature or at 167 deg. F., was slow at 302 deg. but reasonably fast at 392 deg. F. It was found that the alloys age proportionally to the magnesium content.

Impact values were unusually high for light alloys, and they were improved by quenching. The salt spray corrosion resistance of the alloys was good and was generally improved by treatments retaining the beta phase in solution. Manganese additions did not have any effect on the corrosion resistance. Sand cast aluminum-magnesium alloys had a tensile strength of 22,800 to 28,000 lb. per sq. in.; their elongation dropped from 13 per cent for a 3 per cent magnesium alloy to 0 for a 12 per cent magnesium alloy. Quenching in oil at 797 deg. F. was found to gradually increase the tensile strength from 22,000 to 45,000 lb. per sq. in. Their elongation passed through a minimum at 8 per cent magnesium content and reached 15 to 20 per cent for a 12 per cent magnesium alloy. The addition of 0.5 manganese increased the tensile strength by 5 to 8 lb., the effect being more pronounced with higher magnesium content. A 0.5 manganese, 12 per cent magnesium and 87 per cent aluminum alloy was found to have the best casting properties of the series, and after quenching had a tensile strength of 60,000 lb. per sq. in. with an elongation of 12 per cent. These properties were obtained when the molten metal was protected from oxidation and nitriding by a flux such as carnalite and from the action of the moisture in the sand. In the latter case, an addition to the sand of boric acid was quite beneficial. For heat treatment, a heating for 24 hr. at 797 deg. F. and quenching in oil was recommended.

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Carbon and Alloy Steels Turned and Polished Shafting  
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# MACHINE TOOLS

*Herein, for the first time,  
we believe, the reader is  
taken to visit every ma-  
chine tool builder in the  
United States to see what  
each one is doing.*

---

o o o

Let us take an imaginary "swing around the circuit" of the machine tool industry, to see what our American machine tool builders are doing. It will not be too difficult to do this because the industry, as for the past half century, is concentrated in a comparatively small number of centers. Most of these are east of the Mississippi and north of the Potomac and Ohio Rivers.

Our first plant visitations will be made right in our own home town, Cincinnati—"the machine tool center of the world." Located on the Ohio River, the southern border of machine tooldom, this city has within a period of 50 years developed a concentration of machine tool builders outstanding

in number, size, quality of products and soundness in business traditions.

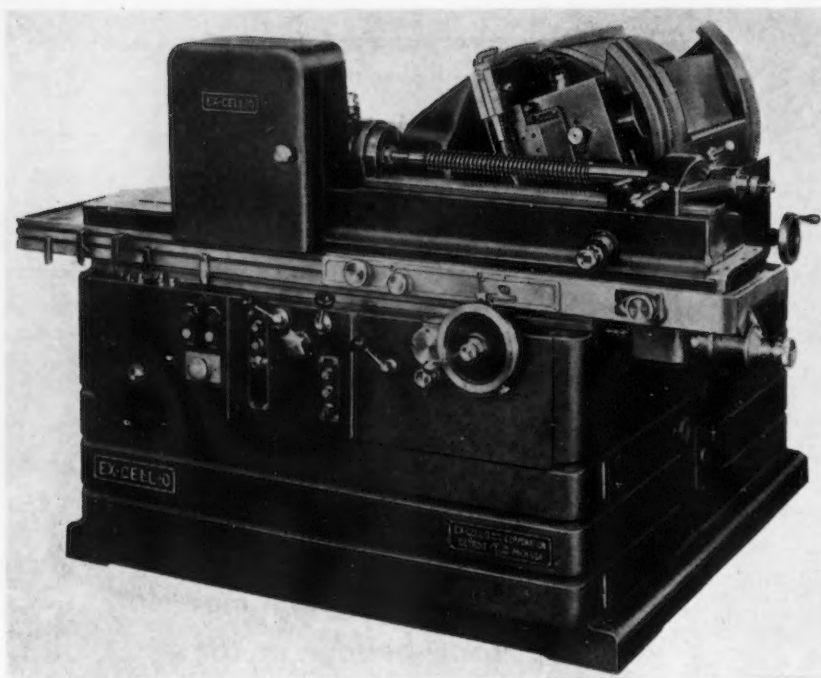
At the *Acme Machine Tool Co.* we find activity in the production of the new line of Cincinnati-Acme universal turret lathes, powerful and rigid machines with enclosed heads and cabinet base motor drive. Nearly every job involves ingenious special tooling, on the design and making of which a great many man-hours and brain-hours are being spent.

Passing on to the *American Tool Works Co.*, we are shown a multi-production lathe which fills the gap between standard engine lathes and highly specialized single purpose automatic lathes. To make it possible for this machine to duplicate work without loss of time for calipering and scaling, a quick scaling setting gage for longitudinal stop dogs, and dual

direct-reading cross feed dials are provided. Designed for fast work with tungsten carbide tools, a new style of chip breaker has been applied to eliminate the hazard of flying chips.

We likewise are shown interesting developments in the radial drill division. Through increase in speed range and rigidity, the standard radials are made to perform with efficiency large diameter boring, facing, tapping and reaming operations in addition to high speed drilling. The new Hole-Wizard line has Allen-Bradley electrical control units built into a cabinet in the radial arm at its column end. These controls consist of overload relays, solenoid starter and reversing switch, with operation from a strategic position relative to the work.

A call on the *Avey Drilling Machine Co.* entails a quick dash



**G**RINDING as a production method on threads has come to the fore very decidedly during the past year. The action and adjustments of this Ex-Cell-O thread grinder are quite clearly shown in the illustration, concentration of control being very obvious. This machine has been "styled" by a leading industrial designer.

across the river to the adjoining city of Covington, Ky. Application of drilling units is much in evidence here, the speed with which special work can be performed in vertical drill presses being greatly increased by the application of additional units working in from the side at any required angle.

Back in Cincinnati proper, we drop in at the *Carleton Machine*

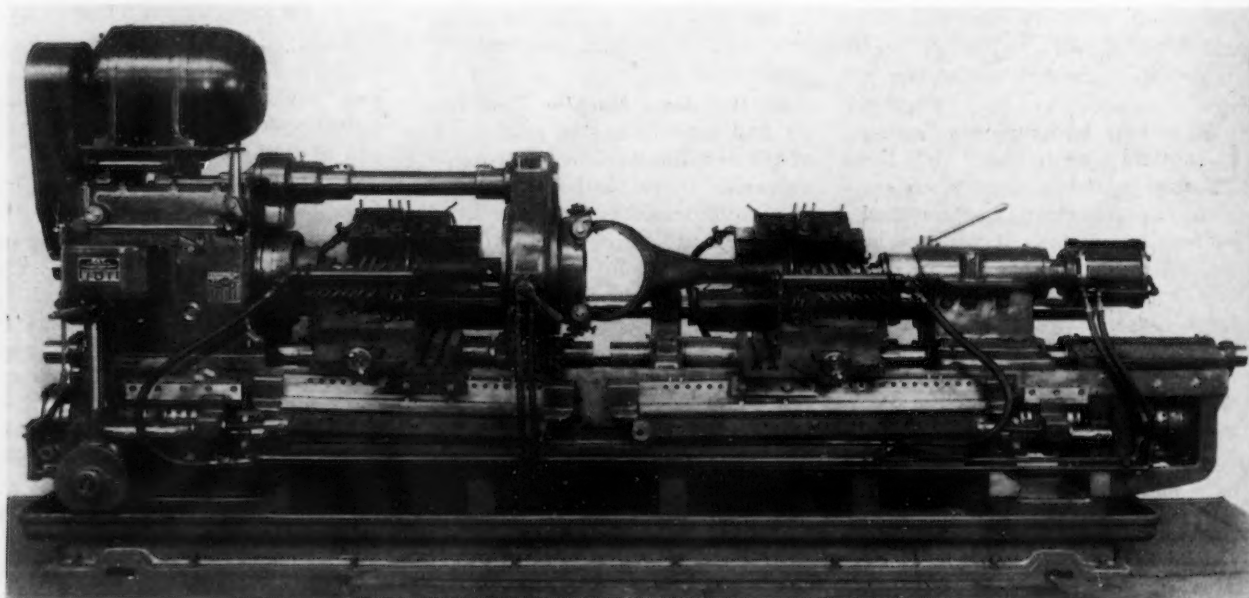
*Tool Co.*, where we again find the unit principle of construction in evidence—this time on radial drilling machines with low-hung drive to give improved balance and smoothness.

An invitation from August Tuechter brings us to the *Cincinnati Bickford Tool Co.* It is hard to believe that here is a man now entering into his second half cen-

tury as a machine tool builder. An interesting feature at this plant is the new type of "low control" for radials, concentration of controls at the place most accessible to the operator having been effected. Growth of the "jig-boring machine idea" is reflected in the application of a new compound table to the Super-Service upright drilling machines, whereby holes can be spaced in two directions to accuracy within 0.001 in. Dual cranks are used, one moving the table ½ in. per revolution, the other 0.100 in. per revolution.

At the *Cincinnati Lathe & Tool Co.* there is much activity in the building of engine lathes up to 36 in. swing and toolroom lathes up to 20 in. swing, with attachments selected or designed to meet the customer's special problems. This business of adapting more or less standard machines to special uses obviously is one of the marked trends of the times.

Back again to the machine tool suburb of Oakley, we have a busy day cut out for us at the plants of the closely related *Cincinnati Milling Machine Co.* and *Cincinnati Grinders, Inc.* Here we find what in many cases is competitive equipment all being manufactured in one group of shops. The equipment can be called competitive by reason of the fact that there is keen rivalry oftentimes between the three systems of metal cutting involved—namely: Milling, broaching and grinding. Analyze the



**T**YPICAL of the special tooling of standard production machines of 1936 is this Fay Automatic arranged with "center drive" effectively to handle both ends of long work. The part shown in the illustration is the rear axle housing of a motor truck, on which several sets of tools are operating simultaneously on both ends.

o o o



"THE machine tool industry went back to school in 1936"—being the highly successful Machine Tool Electrification Forum conceived and carried out by the Westinghouse Electric & Mfg. Co., which was attended by more than 50 leading machine tool engineers. R. S. Elberty is holding the floor.

facts, however, and they will be found to be basically the same. Cutting teeth are involved in all three instances, coarse teeth on circular metal disks (the circular sawing principle) being common in milling practice; similar teeth on straight metal blanks (the filing principle) being usual in broaching; while minute points, usually on wheels (the abrasion system) do the cutting in the grinding method.

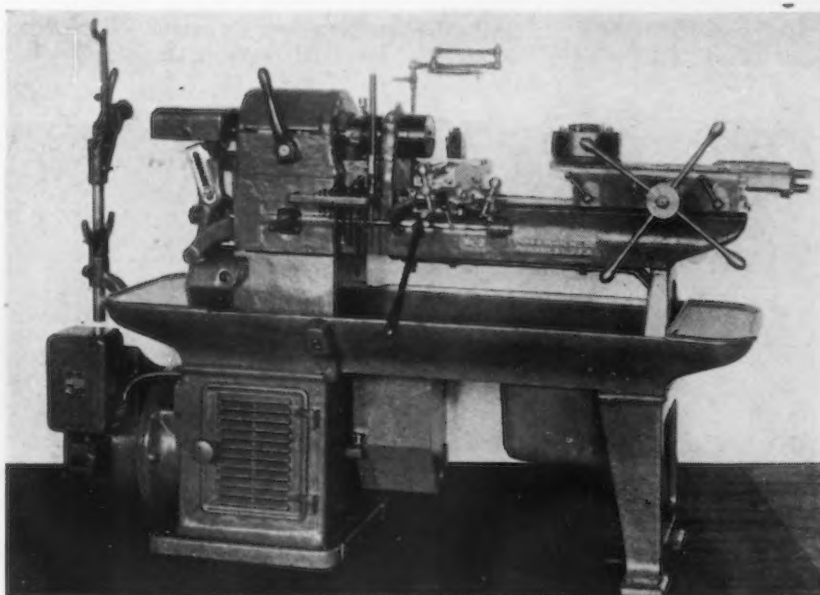
The wide range in size of milling machines is brought out by the contrast between a new and exceptionally neat and rugged appearing horizontal miller of overarm type, designed for such parts as of typewriters, business machines and small arms; and an adaptation of the Hydromatic for handling V-8 cylinder blocks. The latter, with top and side heads, while in effect a special machine, actually is for the most part assembled of standard units.

Comparable to this last, but doing its work by broaching instead of milling, is a large horizontal machine also for motor cylinder blocks. Passing through this machine at the rate of 55 six-cylinder blocks during each "48-min. hr.," the manifold joint face, valve chamber cover pad, fuel pump pad and the long narrow pad immediately below the valve chamber are machined—total area broached being 37.6 sq. in.

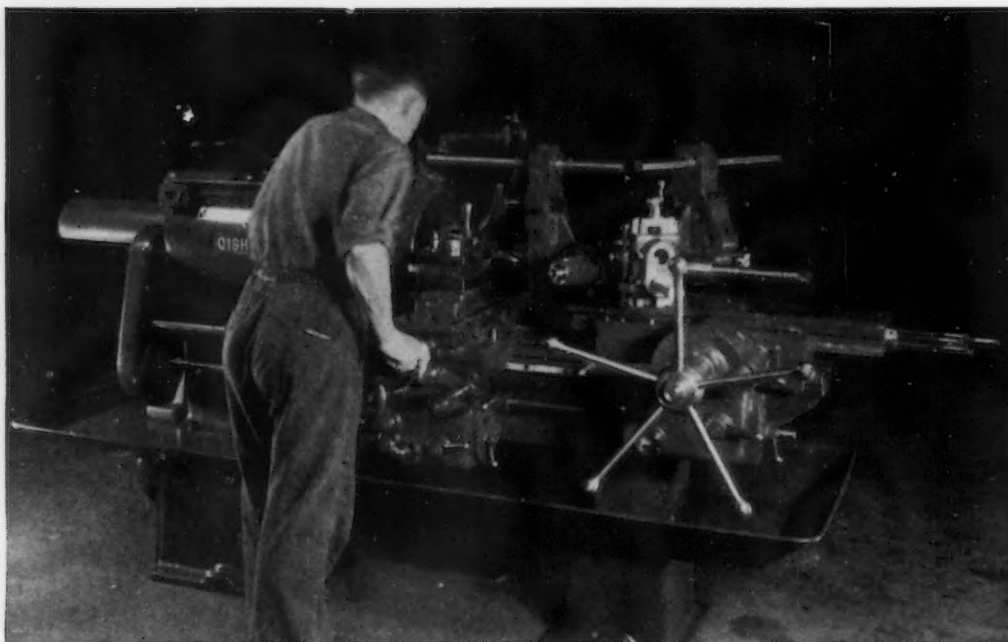
Two other developments, this time in the milling field are a high speed dial-type miller and a Hydromatic miller of unit construction designed especially to mill intricate shapes in tough materials. In the belief that an operator should be "working—not walking" when running a machine, the dial-type has controls arranged so that there is no need to circle around the machine to get at them. But

little operating effort is required because this machine actually shifts its own gears on speed and feed changes.

Now for a look at the grinders. In that division we see a line of roll grinders which rapidly will rough out chilled alloy iron rolls up to 28 in. diameter, and then wind up the job by giving them a "mirror finish." These machines have an independent hydraulic



REDESIGNED during 1936, this Brown & Sharpe hand operated screw machine (turret lathe) has increased spindle speed and offers more convenience in tooling and in operation. It is noticeable that there are no frills in this design, everything being located and shaped for a distinct purpose.



BUILT to fit the operator this Gisholt turret lathe is a labor-aiding machine in that it eliminates or does mechanically a lot of things that used to sap the strength of the operator and distract his mind from the center of interest, which is the work in process.

truing device. We see a centerless grinder, designed originally for precision finishing of large diameter bars, which through use of standard fixtures is made useful on short disks and rings such as bearing races.

Most significant perhaps is the adaptation of the centerless grinder to the lapping of such parts as piston pins, bearing rotors and cups, and valve tappets. Through the generating action of this machine roundness is held to a tolerance of 0.00005 in. (about 1/40 the thickness of a human hair) and straightness to 0.000025 in. on typical piston pin work.

Our next visit is to the *Cincinnati Planer Co.*, certainly a good

"proving ground" for high speed cutting material. We are treated to a demonstration of a Hypo open-side planer with cutting and return speeds up to 240 ft. per min. Openside planers, once considered useful primarily on wide work and capable only of light cuts, definitely have joined the ranks of rugged, accurate high production machines of wide working range.

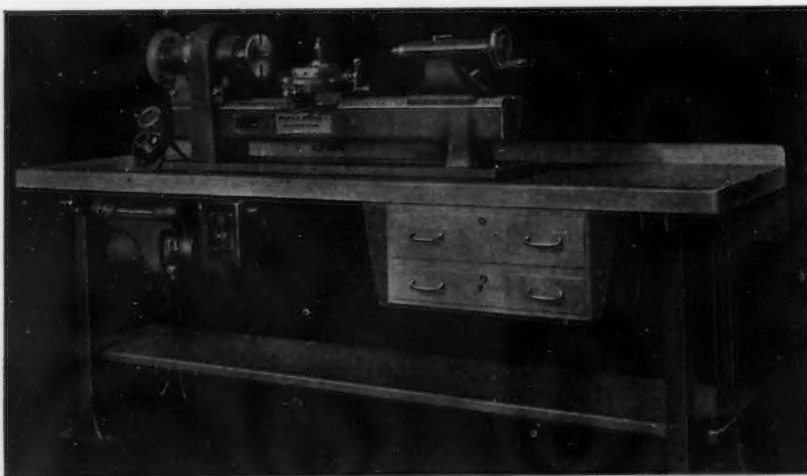
Shapers likewise have stepped over into the ranks of fast metal cutters, as we see during a demonstration of universal and heavy duty rapid traverse types at the *Cincinnati Shaper Co.* While it hardly comes within the scope of this review, we cannot help but remark on the strides made by this

company in the fabrication of machinery by welding—this in their all-steel shears.

Radial drills again come in for attention, this time at the *Dreses Machine Tool Co.*, whose machines ranging from 3 to 8 ft. arm length have been equipped throughout with ball bearings. Here also we are shown new adaptations of the principle of multi-spindle automatic drilling and tapping, and a monitor lathe of 20 in. capacity.

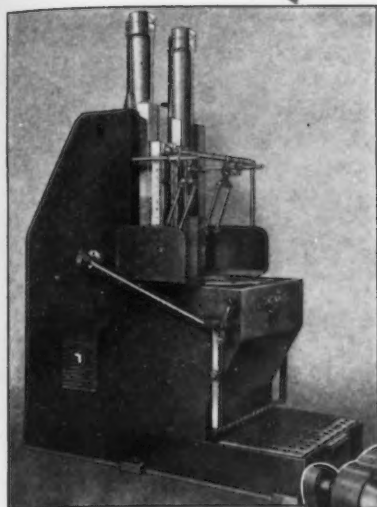
A call upon the *Fosdick Machine Tool Co.* reveals to us what the hydraulic system can do to a radial drill design. In their latest machines it has been applied to the power rapid traverse of the head, to column and arm clamping and to the safety elevating nuts—safety at the same time being provided by hydraulic interlocking. This company also has followed the trend by redesigning a vertical drilling machine into an efficient "jig borer" type machine for doing duplicate work without jigs and fixtures.

Adapting itself to machining methods competitive with planing with single joint tools, the *G. A. Gray Co.* makes use of milling and grinding principles in some of its latest planer type machines. In some cases we find its machines capable of planing, milling, drilling and boring in several planes at one setting, making possible the complete machining of large intricate work in the one machine. Electrical control has been brought



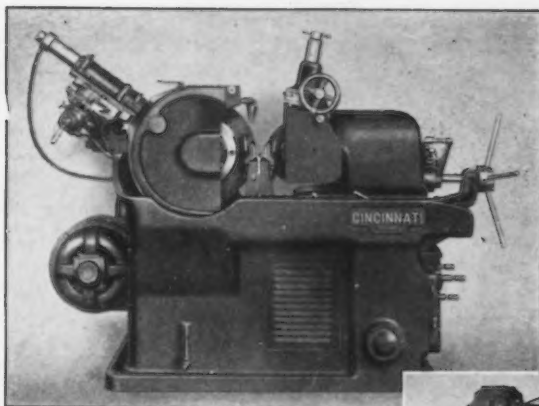
**PRATT & WHITNEY** bench lathe with precision ball bearing spindle and Transitorq drive. While designed to handle work of high accuracy, this machine also is ruggedly built to maintain this accuracy under day in and day out production conditions. Note the heavy, yet well proportioned bed.

# SHOP



## Duplex Vertical Hydro-Broach Machine

A surface broaching machine for large quantities of the medium size work-piece. Very accurate and rapid production. Made in various sizes, ranging from 36" to 54" strokes. Horizontal machines available.



## No. 2 Centerless Grinding Machine

A machine for grinding straight or tapered cylindrical parts by the centerless method. Very accurate and rapid production. Made in various sizes and styles. Adaptable to grinding bar work.

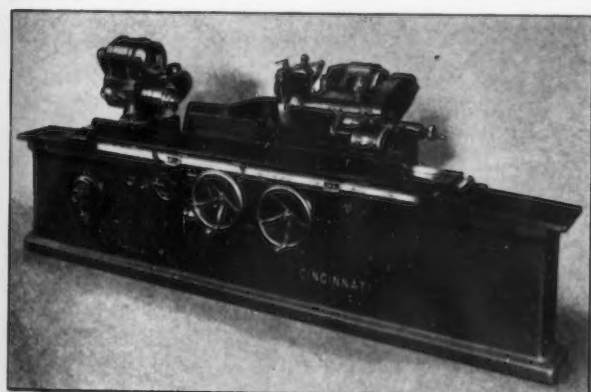
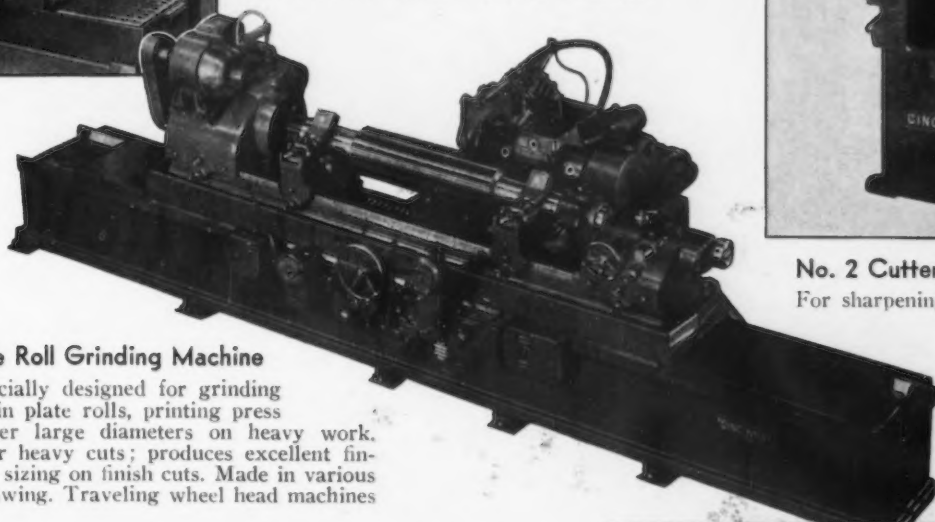


## No. 2 Cutter Sharpening Machine

For sharpening milling cutters, reamers, hobs, or any other cutting tool used in a machine shop. Also very convenient for grinding gages or other light tool room work. Plain or universal style.

## Traveling Table Roll Grinding Machine

A machine especially designed for grinding working rolls, tin plate rolls, printing press drums, and other large diameters on heavy work. Very rugged for heavy cuts; produces excellent finish and accurate sizing on finish cuts. Made in various sizes up to 28" swing. Traveling wheel head machines also available.



## Universal Self-Contained Grinding Machines

For accurately grinding medium to large size work by the between-center method. Made in the plain and universal styles, 14" to 16" swing, and various lengths up to 168" between centers.



## Plain Hydraulic Grinding Machine

For accurately grinding small to medium size work. Very simple to operate and rapid producer. Made in the plain style only, 6" or 10" swing, 18" and 30", or 18" and 36", respectively, between centers.

# CINCINNATI GRINDERS INCORPORATED

## CINCINNATI, OHIO U.S.A.

to a high degree of refinement in its machines.

Similar cases of adaptation of "competitive" machining methods are found at the **King Machine Tool Co.**, where in special cases milling and grinding heads are applied to machines of the vertical boring mill type ranging from 30 to 120 in. capacity. At this plant it is a pleasure to meet its president, vigorous and cheerful after two generations in the machine

tool industry and after two terms as president of the Machine Tool Builders' Association during the most critical days in the history of the industry.

That the word "lathe" today may mean many things, is proved by a trip through the **R. K. LeBlond Machine Tool Co.**, where we learn that there are "lathes and lathes." For those who want "just a simple engine lathe" there is the Regal line. Then we find more

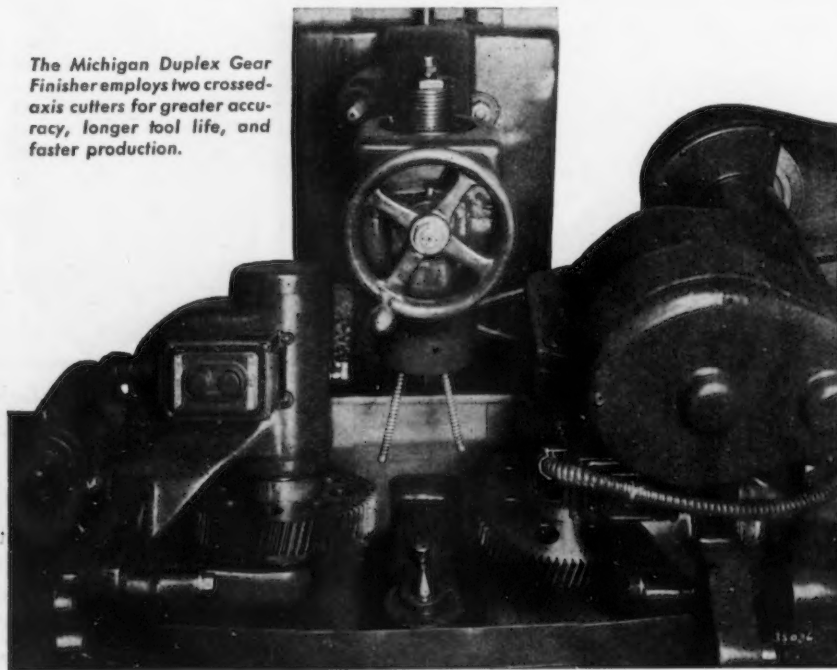
complete heavy duty rapid production lathes. Then come Multi-cut manufacturing lathes for simultaneous turning and facing. For high speed work there are motor head rapid production lathes in which the spindle is the armature shaft and its speeds from 450 to 3600 r.p.m. There are gap lathes giving large swing, heavy duty engine lathes and universal turret lathes.

We are shown a special automatic chucking lathe for turning grease retainer grooves in bores of ball bearing races. It has a New Departure Transitorq drive, air-operated tool carrier and cam-operated feed. Typical of highly developed special design is an automatic four-station crankshaft lathe whose use eliminates straightening as well as rough grinding. Four stations on a revolving drum advance the crankshaft progressively from the loading-and-unloading station through three machining operations. In each one only a small amount of stock is removed, thus putting minimum strain on the cutting tools. A finished shaft is turned out with each movement of the carrier drum.

At the LeBlond plant we see one of the several recently developed new-type spindle noses providing rapid, accurate, positive and interchangeable placement of lathe chucks, face plates and fixtures. A heavy key in a tapered nose allows the chucks, etc., to be hung on the spindle, the operator then using both hands to start and tighten a loose, threaded collar which seats the chuck firmly on the tapered nose.

Our final visit in Cincinnati on this preliminary round to get acquainted is to the **Lodge & Shipley Machine Tool Co.** The company has developed a high speed lathe with finger-tip control giving infinitely variable speed within its wide range. At the other extreme of the line is a new 18-in. manufacturing lathe with selective head. This machine has been designed to rival an automatic in production possibilities, at the same time retaining the versatility of an engine lathe. It fits the gap between general utility and highly specialized machines. And so, after several days of rushing about a great industrial city and its environs, we have hit the high spots of Cincinnati's

The Michigan Duplex Gear Finisher employs two crossed-axis cutters for greater accuracy, longer tool life, and faster production.

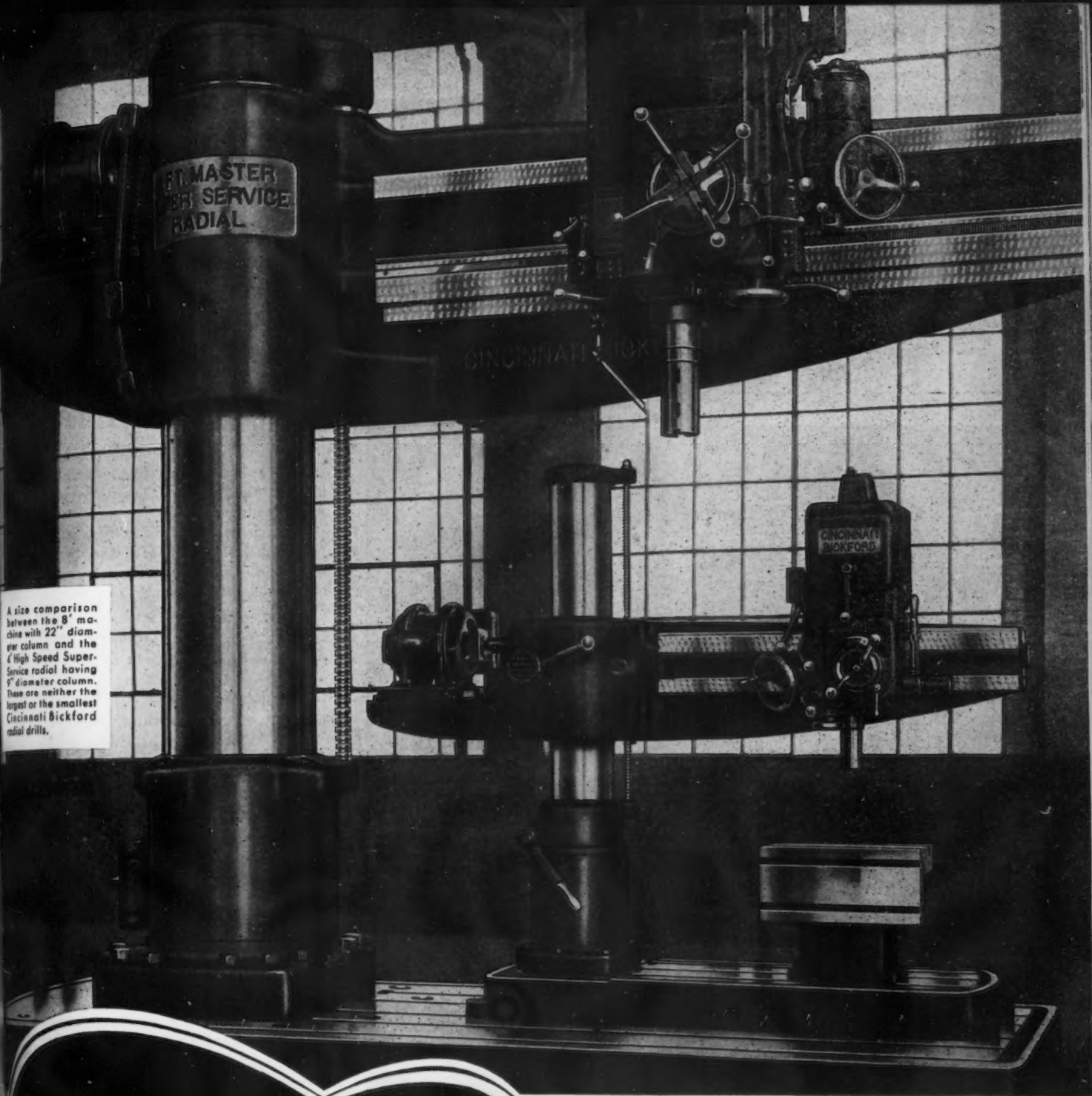


## GEAR CUTTING NEWS

Designed for relatively short production runs and for finishing large varieties of only a few gears each... where full advantage cannot be taken of the long tool life, lowest possible tooling cost per piece, and minimum production time of rack type of finishers... the Michigan Duplex brings to the rotary gear finisher field higher standards of accuracy, faster production, and lower tooling cost per piece than obtainable heretofore. A feature of the use of two cutters is the ability to finish two gears of different characteristics in a cluster or both halves of a herringbone simultaneously.

Write for complete information on engineering and tooling services.

**MICHIGAN TOOL COMPANY**  
7171 E. McNichols Rd. DETROIT, MICHIGAN



A size comparison between the 8' machine with 22" diameter column and the 4' High Speed Super-Service radial having 7" diameter column. These are neither the largest or the smallest Cincinnati Bickford radial drills.

*Advanced  
Mastery in  
Drilling Performance*

## MASTER Super Service RADIALS

CINCINNATI Bickford presents to the trade whose drilling requirements exceed those of average need—an advanced line of Master SUPER SERVICE Radial Drills—designed to accommodate massive machine parts, such as are encountered in the manufacture of rolling mill equipment, Diesel engine frames, turbine casings and huge generator housings. " " This 40 H. P. tool is built in sizes ranging from 7' arm and 22" diameter column up to 12' arm and 26" diameter column; the largest and most powerful radial drill ever built. " " May we mail you our newly printed bulletin, fully illustrative and descriptive of this Advanced Mastery in Drilling Performance?

**Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio**

machine tool industry—but after all, only the high spots.

At the beginning of machine tool journey number one, we head north through Ohio, and our first stop is at Hamilton to call on the *Niles Tool Works*. Vertical boring mills of large size are built here, without which great ships, and power developments and other things calling for machining of elements of huge size, would hardly be pos-

sible. There are in this country relatively few boring mills of very large size, and their tremendous importance to industry in times of peace and in times of war.

In Hamilton we also stop in at the *Columbia Machine Tool Co.* to see a line of crank shapers featuring high cutting speed and still higher return speed—an example of elimination of “idle” or “non-productive” time.

At Dayton a stop is made at the *Cimatool Co.*, and a demonstration is made of a double spindle “Peerless” machines for chamfering and burring external gears up to 13 in. in diameter. This machine, which is hydraulically operated even to clamping of work, functions at speeds as high as 300 gear teeth per min.

Springfield, Ohio, one of the three Springfields of machine tool renown, calls for a visit to the *Thompson Grinder Co.* and also to the *Springfield Machine Tool Co.* At the former plant we are struck by the unusually trim appearance of large hydraulic surface grinders on the assembly and testing floor, while at the latter one we observe a trend toward special purpose machines of the lathe type in spindle and axle boring machines of improved design.

On then to Sidney, where our first stop is at the *Monarch Machine Tool Co.*, where we find engineering and production developments as advanced as are the industrial and marketing ideas of W. E. Whipp, the president and moving spirit of this company. Interesting—as always—are the Magnamatic lathes in which, through the Keller electro-magnetic control system, sheet metal templates are made to guide the turning tools along intricate contours. This is a direct step toward direct transition of a part from drawing to actuality. Another development is a lathe with hydraulic drive giving automatic changes in spindle speed to suit different diameters on long work or the constantly varying diameter in facing.

A direct-reading dial unit now is available to indicate lathe carriage travel to 1/64 in. This unit is attached either to the left or the right hand wing of the carriage, with a hardened pinion meshing with the rack on the lathe bed. One complete revolution per ft. of carriage travel is made by an inner dial, while each inch of travel produces one revolution of a concentric outer dial graduated in 64ths. Both dials quickly can be reset to zero, so that successive lengths readily can be measured when turning or boring.

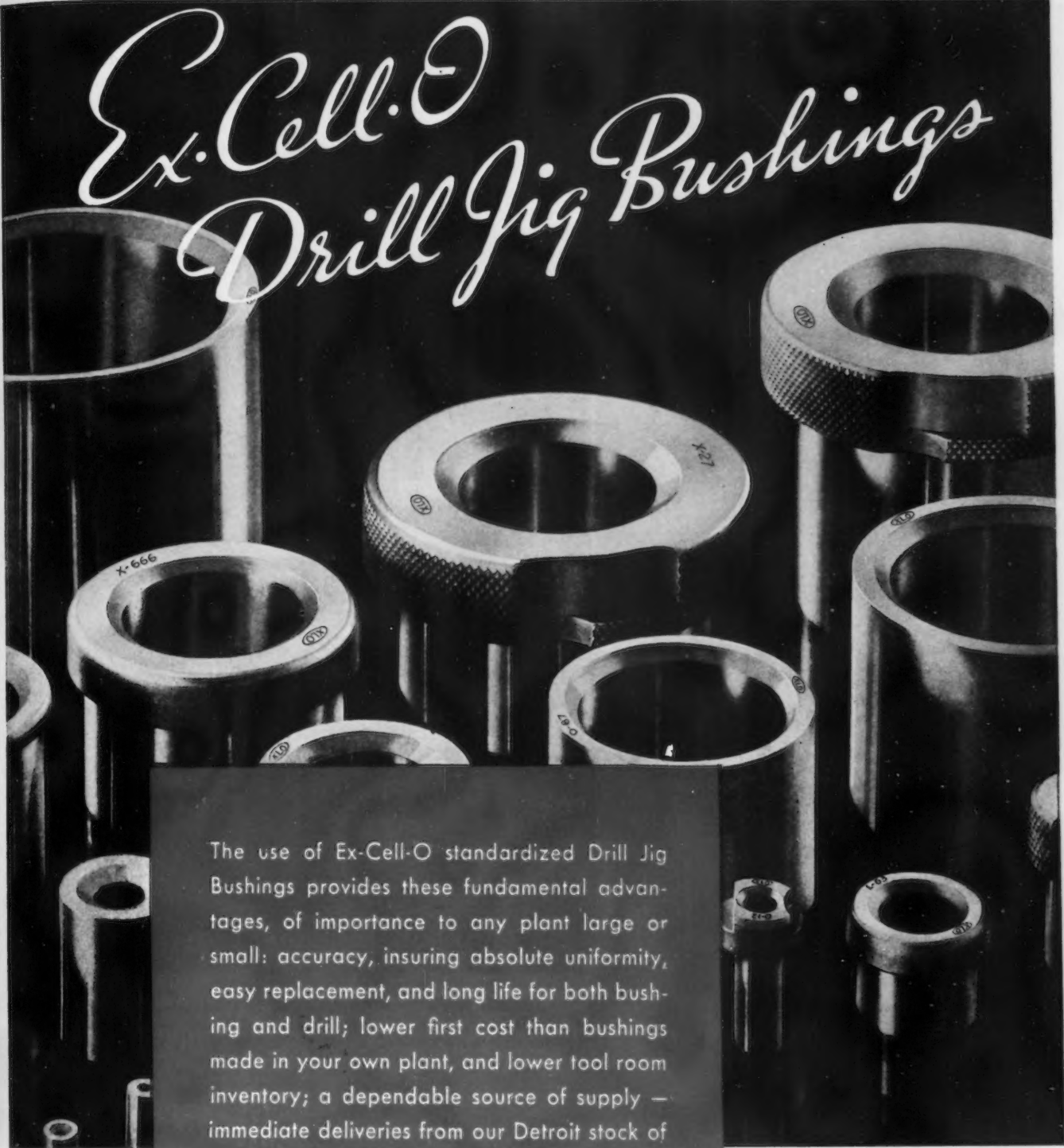
Use of heat treated steel parts has been widely extended in the new Monarch lathes, and a cam lock spindle nose, optional on all models, makes it possible quickly



**THE RIVITOR** automatically feeds and sets solid rivets with speed and precision, and it pays for itself by enabling you to substitute solid rivets for other types of rivets. Write us for specifications.

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European Office—Gaston E. Marbaix, Ltd., Vincent House, Vincent Square, London, S.W. 1, England.

# Ex-Cell-O Drill Jig Bushings



The use of Ex-Cell-O standardized Drill Jig Bushings provides these fundamental advantages, of importance to any plant large or small: accuracy, insuring absolute uniformity, easy replacement, and long life for both bushing and drill; lower first cost than bushings made in your own plant, and lower tool room inventory; a dependable source of supply — immediate deliveries from our Detroit stock of a quarter million bushings, an emergency stock in New York.

There is a complete range of Ex-Cell-O bushings and liners in types, sizes, and lengths to meet every general requirement. Special bushings are available upon short notice when required. Send for complete information, including bushing data sheets and price lists.



**EX-CELL-O AIRCRAFT & TOOL CORPORATION**

**DETROIT • MICHIGAN**



THAT a machine tool can be a beautiful object as well as a utilitarian one is demonstrated by this Cataract precision milling machine of bench type, manufactured by Hardinge Brothers, Inc. It is noticeable even in this tool room machine that there has been an "automobile influence"—the knobs on the control levers being inspired directly by automobile shift levers.

and securely to lock face plates, chucks, and fixtures in place.

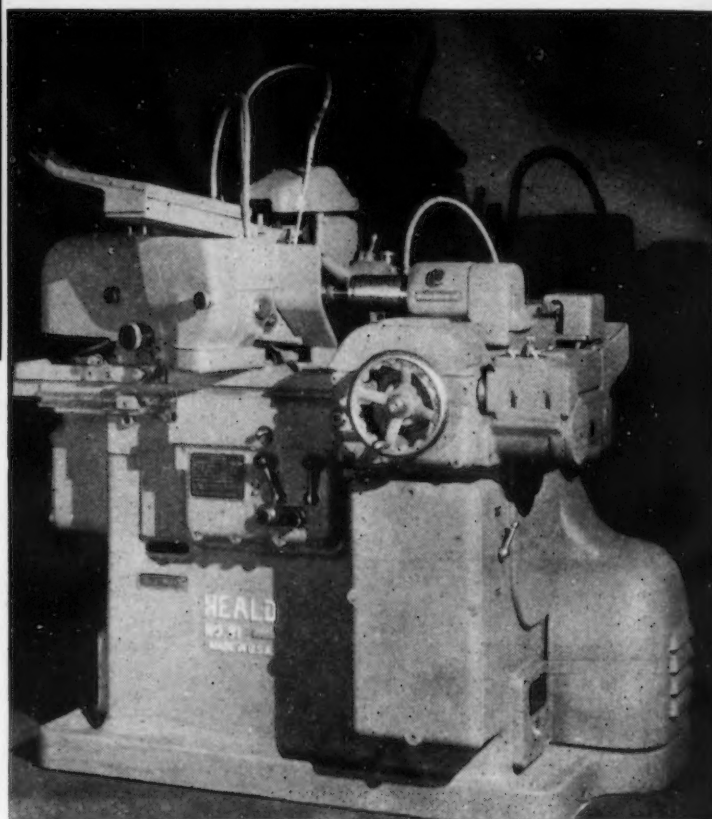
Before leaving Sidney there is another visit to make—to the plant of the *Sidney Machine Tool Co.*, whose lathes now embody 12-speed sliding gear heads.

Our next hop is to Kenton, home of the *Ohio Machine Tool Co.*, builder of shapers, planers and

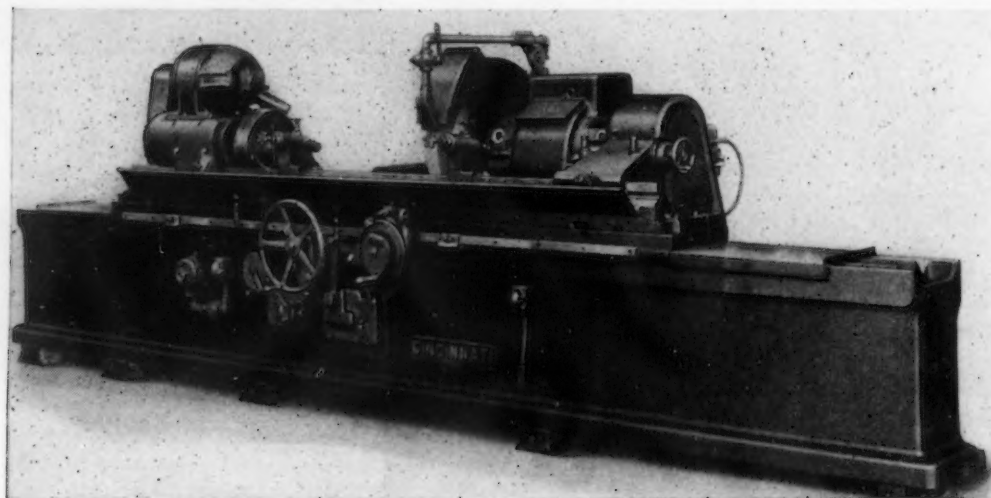
horizontal boring, drilling and milling machines. Among its recent developments, shapers with "one-position" control are particularly interesting. In these machines complete control of feed and rapid traverse is concentrated at the end of the cross rail—includ-

ing a feed-change dial graduated in thousandths. Incidentally, the feeding action occurs during the return stroke of the ram, thus reducing wear on the tool.

On the assembly floor of the *Defiance Machine Co.*, Defiance, Ohio, we are allowed to see a two-way opposed hydraulic feed face milling machine for simultaneous milling to two faces of castings. This machine, which has a unique cruciform base, gives an automatic

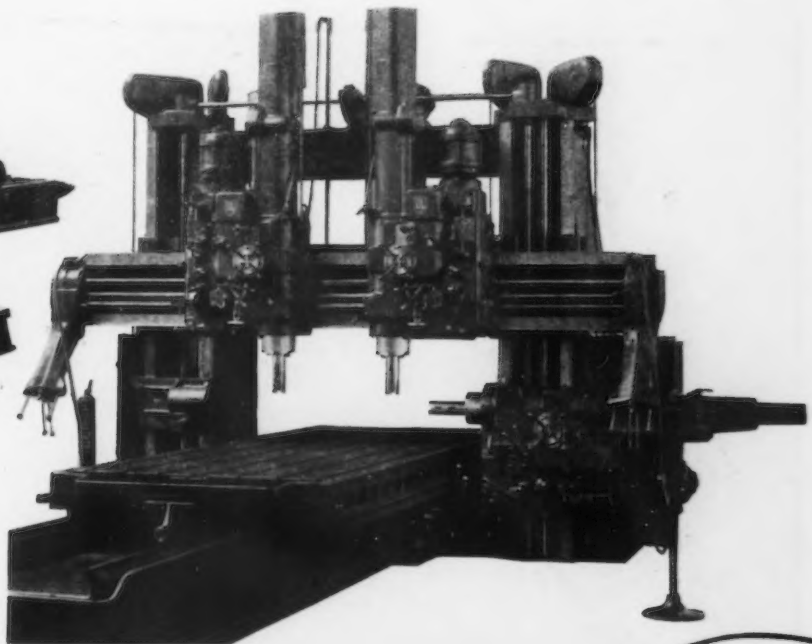
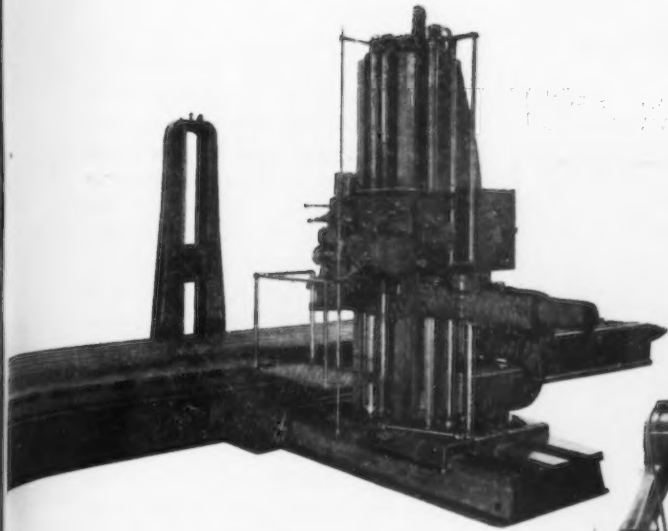
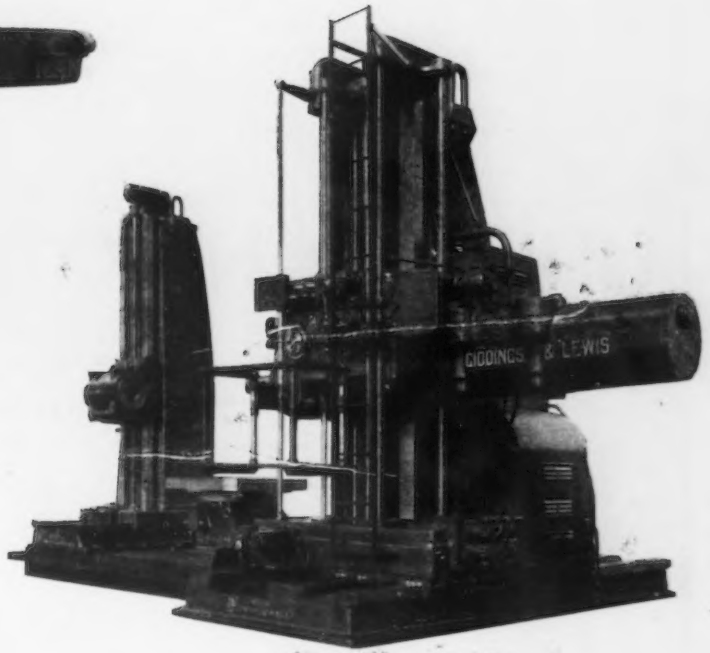
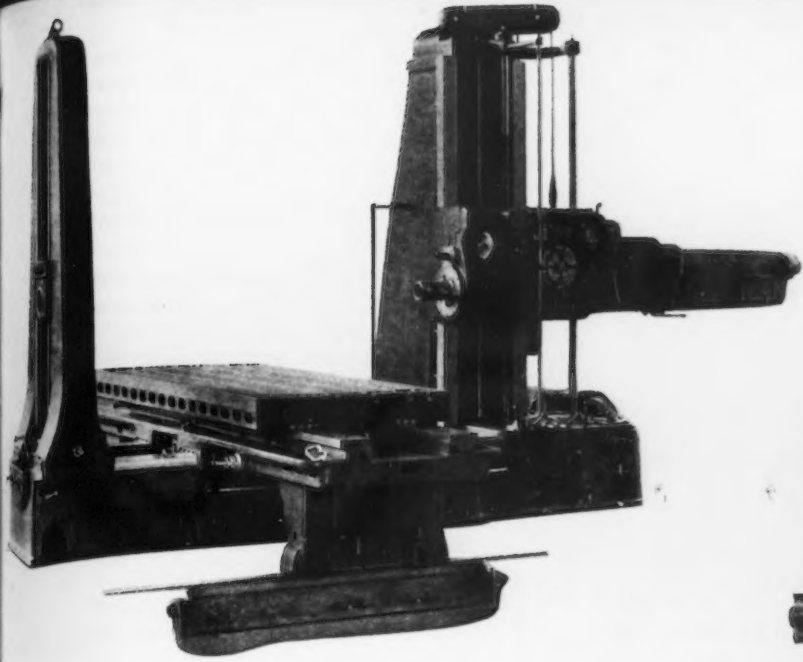


GUARDS can give a finished appearance to a machine as well as safety. In this case the Heald engineers made a point of "sweeping" the numerous guards into the ensemble of the machine, which is a high-speed internal grinder for small bore work.



THE modern heavy-duty cylindrical grinding machine has the characteristics of an extremely stiff box girder bridge which must not "give" even a few ten-thousandths of an inch and which must soak up any vibration which may develop. This is a recent design by Cincinnati Grinders, Inc. of 14-in. or 16-in. swing. Note the massive wheel head.

*from* 1862 *to* 1937



AND

**LEWIS**

**FOND DU LAC, WISCONSIN**

1862  
1937

cycle of fast advance, cutting feed, and rapid return—with skip feed possible.

Having traversed Ohio from the big river on the south to the great lake on the north, we find ourselves in the state's number two machine tool center, Cleveland. This busy industrial city, central to the widely diversified metal working industry and with its huge underground exhibition hall, also has proved to be an ideal location for the National Machine

Tool Shows, of which that of 1935 is still exerting its influence in the buying of machine tools.

The **Warner & Swasey Co.**, organized in Cleveland nearly 60 years ago, has as the chairman of its board Ambrose Swasey, who celebrated his 90th birthday in December, 1936. He is the dean of American machine tool builders, typical of an earlier generation which, starting as apprentice boys in the shop, developed in the hard school of experience to be out-

standing engineers and industrialists.

One is struck in this plant by the splendid quality and fine finish of the castings used in building turret lathes, and by the infinite attention given to minor design details which, after all, when considered collectively, are of major importance.

• Here we see a small turret lathe, with motor-on-spindle, machining brass at such speed that there is only a momentary spray of bright yellow chips before the finished piece drops off. At the other extreme we see a very large universal turret lathe of 100 hp., with its tool buried an inch deep in a ton-and-a-half tough steel forging, removing 50 cu. in. of metal every 60 sec.

The performance in the first case would have burned up the tools of 10 years ago, and in the second case would have wrecked the machine tool of that same era. A sign of the times at the Warner & Swasey plant is the large separate engineering department devoted to the design of tools by which standard turret lathes are made best to serve the special requirements of customers.

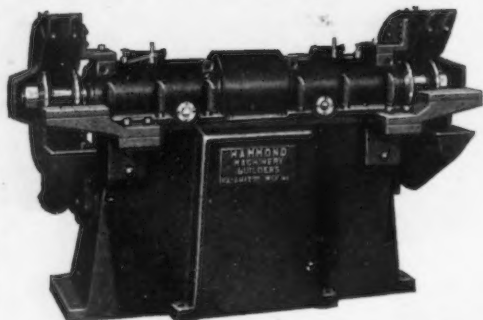
Crossing busy Carnegie Avenue, we drop in at the **Lees-Bradner** shop where we see demonstrated the hobbing of gears in an automatic multiple station gear hobbing machine whose tools are controlled from what might be described as a "central brain-case" built into the machine.

At the **Foot-Burt Co.**, builder of drilling and broaching machinery, there is an example of what can be done with standard drilling units in the building up of a special purpose machine. It is a five-way, 92-spindle drilling machine for an automotive plant. Still another example is a 25-spindle combination drilling, chamfering and tapping machine with a 4-position circular indexing table, likewise developed for machining an automobile part.

From there we go over to the **National Acme Co.** for a demonstration of new automatic 4 and 6-spindle chucking machines equipped with 8-in. electrically operated chucks. Parts have been rearranged to give open construction below the spindles so that chips, coolant and work will fall freely into the pan.

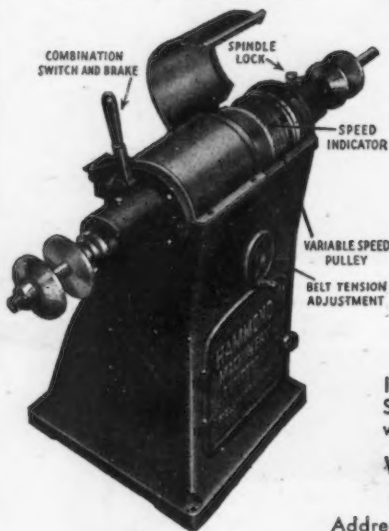
The problem of accurately spac-

## UNLIKE ANY OTHER GRINDER OR POLISHER



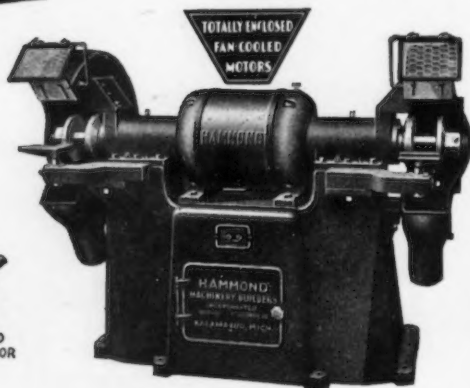
### Hammond Heavy-Duty Grinders

Type WH—5-7½-10 H.P. Four Bearings—Ball or Timken Roller Bearings. Totally Enclosed Fan-Cooled Motors.



### Hammond Hi-Speed Snagging Grinder

Type WC—7½-10-15 H.P. Single Spindle—1 Motor.  
Type WWC—5-7½ H.P. Double Spindle—2 Motors.  
Totally Enclosed Fan-Cooled Motors Mounted Rear of Base. Multi V-Belt Drive.



### Hammond Vari-Speed Polishing Lathes

Type RV—3-5-7½ H.P. Single Spindle—Motor in Base. Multi-V-Belt Drive—Heavy Duty. Four Ball Bearings on Spindle.

Incorporates Hammond Patented Variable Speed Drive—UNLIMITED SPEEDS. Also built with two spindles and two motors.

Write for Bulletins descriptive of the complete line of Hammond Grinders and Polishers.

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*Hammond Machinery Builders*  
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ing the spindle holes in spindle carriers has been solved by the use of a Heald precision boring machine equipped with special indexing fixtures. The holes are held to size tolerance of 0.0003 in. and are spaced within 0.0005 in.

Our next stop is at the **Lucas Machine Tool Co.**, builder of precision horizontal boring, drilling and milling machines. Here a new model has just been completed which has been designed especially for large work requiring extra operating range. Limits of accuracy on these machines are among the closest of any of the larger machine tools.


A call at the **Cleveland Planer Co.** reveals further developments in openside planers, through which the stiffness of these machines has been increased to the point where the heaviest cuts of which modern planer tools are capable can be taken.

Gear hobbing again comes to our attention at the plant of the **Cleveland Hobbing Machine Co.**, where a demonstration is given of spiral bevel hobbing. There we also examine on the assembly floor an eight-spindle rotary rigid-hobber developed primarily for the mass production of high grade automotive gears.

The wide range of work done on automatics nowadays becomes apparent at the **Cleveland Automatic Machine Co.**, where there are being built single spindle bar machines from  $\frac{5}{8}$  in. to 8 in. capacity, four-spindle from  $\frac{5}{8}$  in. to  $3\frac{3}{4}$  in. and six-spindle from  $\frac{5}{8}$  in. to  $2\frac{1}{4}$  in., also four-spindle chucking machines up to 9 in. and six-spindle up to  $6\frac{1}{2}$  in. The new models are neat in appearance, and it is noticeable that not only has operating speed been increased but also that all the non-cutting movements such as stock feeding and indexing have had their time cut down.

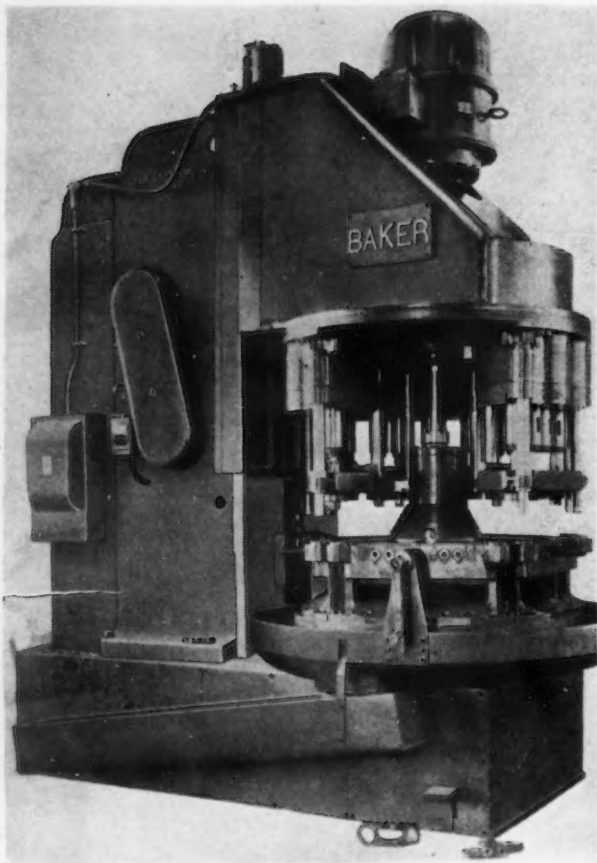
At the shop of **Bardons & Oliver** we have an opportunity to watch activity in production of a redesigned line of geared head turret lathes of both ram and saddle type. A demonstration gives convincing evidence of their ability to do smooth, accurate work at speeds and feeds associated with the latest cutting materials.

Before concluding our round of the Cleveland shops, we have three more to call on—each building horizontal threading machines, a type



*remember —  
its not taking them out  
but keeping them in that  
makes old Turret Lathes  
so expensive*

**WARNER & SWASEY . Turret Lathes . Cleveland, Ohio**



o o o

#### AT LEFT

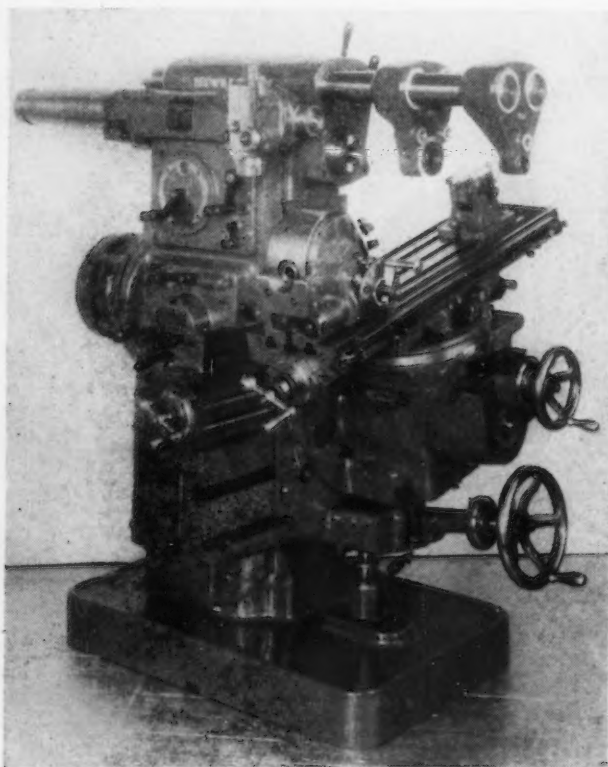
WHILE this multiple drill by Baker Brothers has been set up to handle a particular part, the design is such that at no great expense it can be rearranged to handle some entirely different part.

o o o

for which Cleveland has a wide reputation. Such machines as those now built by the *Acme Machinery Co.*, the *Breckenridge Machine Co.*, and the *Oster Mfg. Co.*, really are heavy duty tools which within the rather broad limits of their distinctive field will keep pace with any equipment in association with which they may be called upon to perform. These rugged, clean cut machines, with their built-in motor drives, have indeed come a long distance from

#### BELOW

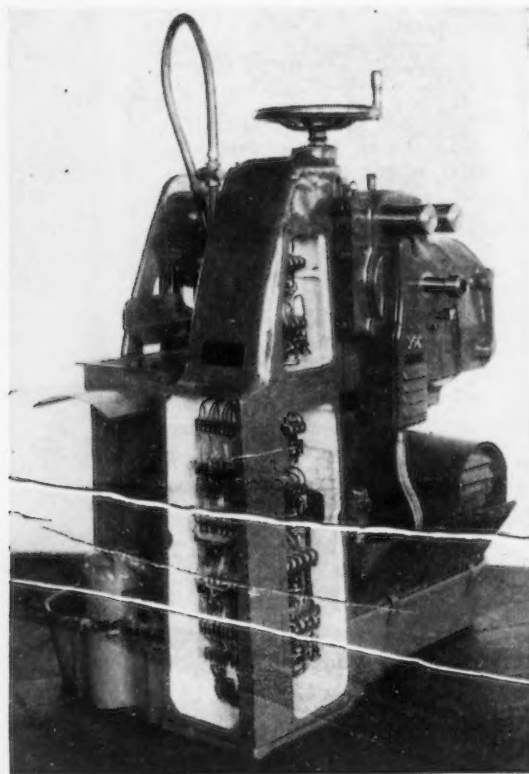
THE surprising number of adjustments possible on this Brown & Sharpe milling machine makes it possible to do work with simple setups which ordinarily would require elaborate jigs and fixtures. There was a time when "allaround" machines such as this were inclined to be weak in construction, but modern practice in frame, gib and slide design makes this new machine extremely rigid in any of its almost innumerable settings.



#### ABOVE

HERE is what it means to really "build-in" full electric drive and control. This is the column of the Brown & Sharpe full-electric milling machine with its covers removed to show the array of relays, contactors, etc., required. Today the electrical engineer is a potent factor in the engineering department of a machine tool builder, and tomorrow he will be still more so.

o o o



the simple pipe-threader of other days.

Let us now head west from Cleveland. At Toledo we make our first machine tool contact in that direction. There *Baker Brothers, Inc.*, has something new to show us in its wide line of standard and special production drilling machinery. It is what the company calls its Clean Line vertical drilling machine with a handsomely streamlined frame from which all ungainly warts and bunions have been eliminated. Unit construction plays a very important role in this plant.

At Toledo we also stop at the *Kent-Owens Machine Co.* Milling machines are their specialty, the line including plain, power feed,

cam feed and automatic types. This company is a successful example of one which has diversified by building high grade special machinery other than machine tools.

Leaving Toledo we soon cross the line into the state of Michigan, in which a tremendous volume of machine tool equipment is sold and in which no small amount is now being built. Our first stop is at Adrian, where in the shop of the **Oliver Instrument Co.** we see the latest things in die-making machines and tool grinding machines. With modern cutting tools deserving to be called "precious metal" and with definite knowledge now available on the most effective tool angles, the tool grinder has stepped over into the class of precision equipment.

Next we jump to Detroit, which is the great machine tool using city of America. Without a doubt the automobile plants of this city have inspired more machine tool builders with more new design and production conceptions than has any other factor. At the same time, what machine tool builders have done to make possible the feats of production in the American automobile industry never can be fully realized, least of all by the general public.

Our first call in Detroit is at the **Ex-Cell-O Aircraft & Tool Co.**, whose precision machines as styled by a well-known industrial designer lately have attracted favorable attention in the world of art. Center of interest here is the new universal type precision thread grinding machine. Automatic except for loading and unloading the work, it will grind threads up to 8 in. in diameter and up to 24 in. long, this to a predetermined size setting. Ex-Cell-O also has had a hand in tool grinding machine development, its machine for carbide tipped tools utilizing diamond wheels and lapping disks.

At the **Hutto Division** of the **Carborundum Co.**, we are given a demonstration of what can be done by the honing process. On a recently developed vertical machine with variable speed hydraulic drive, no difficulty is experienced in holding work to a limit of 0.0002 in.

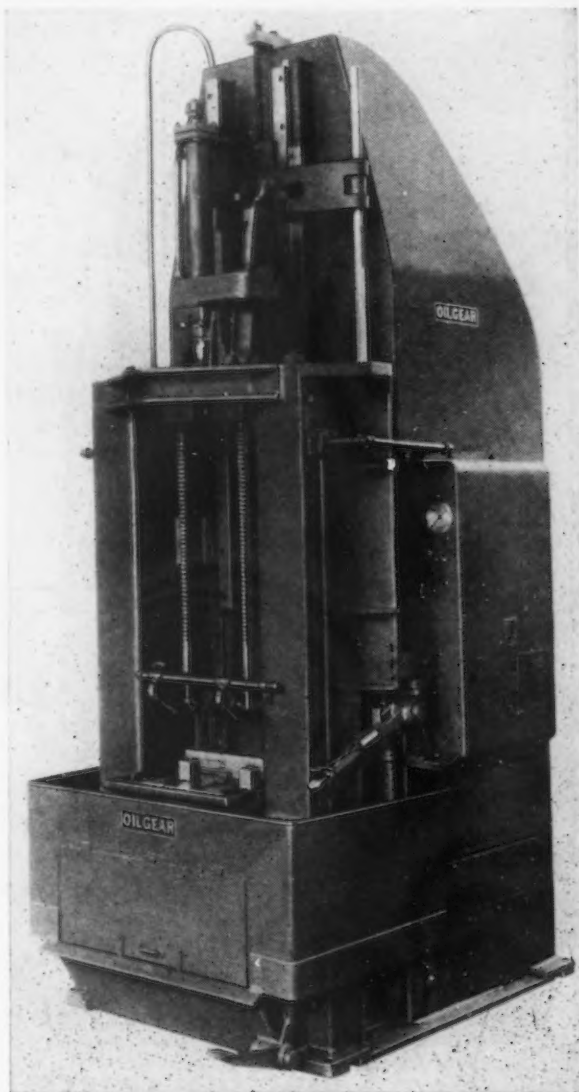
On then to the **Colonial Broach Co.**, where there are once more

in evidence the advantages of the unit system of construction, especially on machine tools for the automobile industry. Several single-ram Colonial broaching machines can be mounted on a single base and provided with continuous feed fixtures for "line production

of lead screws on extra fine work.

Our visit to the **National Broach & Machine Co.** is inspired in part by curiosity about a new method of finishing gears. This we learn from a demonstration is called "crossed axis shaving," in which the cutter used in the new Red

As a manufacturer of broaching machines as well as of hydraulic systems, the Oilgear Corp. demonstrates that as a good engineering structure a machine tool can at the same time have lines which are pleasing to the eye from the standpoint of looking "strictly business." This dual machine has, of course, hydraulic drive and control.

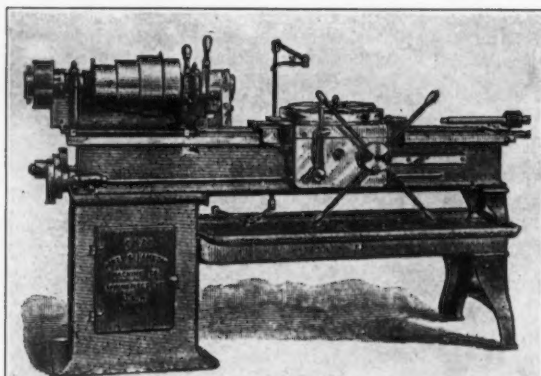


broaching." Welded steel construction is used in conjunction with cast iron so that each contributes its particular advantages to the assembly, this ensemble having extraordinarily clean lines.

We find at the **Murphy Machine & Tool Co.** that the tide of machine tool development has not missed its horizontal threading machines. Preloaded ball bearings are used throughout, enabling speeds to be stepped up; the dies use tangential or circular chasers; and provision is made for the use

Ring machine really is a helical gear with gashed teeth. Running in mesh with the gear being finished, this gashed gear takes light, fast cuts resembling those of a fly cutter, removing all roughness and interferences.

Next comes Ann Arbor, where at the shop of the **Buhr Machine Tool Co.** are interesting examples of what can be done with the universal power units which are the specialty of this company. On its assembly floor are complete way drilling and tapping machines



**Jones & Lamson Machine Co.**  
SPRINGFIELD, VERMONT.

SOLE BUILDERS OF THE

**FLAT TURRET LATHE,**  
And other Turret Machinery.

Send for Catalogue.

# CONTINUAL

**I**N business for 102 years — building turret lathes for the last 88 years—thus reads the history of J&L. Always a pioneer in new development, the Jones & Lamson Machine Company enters 1937 with the most complete line in its history; a line that is completely modern; a line so advanced in design that its labor-saving features establish it as the leading money-maker in its field.

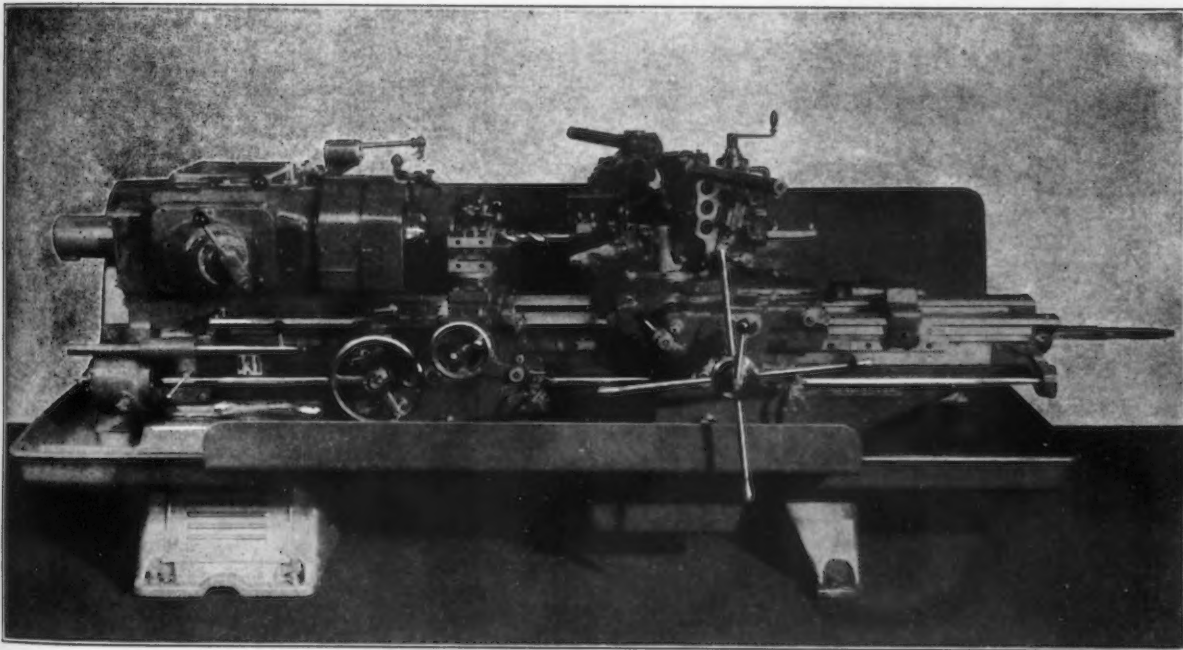
**JONES & LAMSON MACHINE CO., Springfield, Vt., U.S.A.**

1835



1937

# PROGRESS



which have been built up by assembling these units on special frames to suit the work.

At Ann Arbor there also is located the *American Broach & Machine Co.*, whose line includes about everything new in broaching machines; vertical, horizontal, hydraulic, mechanical or hydro-mechanical, push, pull and rotary surface types.

Our visit to Ann Arbor would

be incomplete were we not to pay our respects to Prof. Orlan W. Boston whose experiments on metal cutting tools at the University of Michigan have given data of great value to machine tool designers.

The itinerary next calls for a jump to Saginaw to call at *Wickes Brothers*, builders of lathes. We find that they have developed a unique heavy duty tool for machin-

ing the rugged crankshafts used in diesel engines and tractors. After he has chucked a crankshaft, the operator presses a button, whereupon the machines goes through the following completely automatic cycle: Rapid traverse of tools to cutting position; coarse feed for "cheeking," fine feed for turning; dwell, during which the cutting tools are held in position for five or six revolutions to "clean up the cut"; stop at exact diameter; rapid traverse to unloading position; and stopping of machine at unloading position.

At Jackson we drop in to see *C. B. De Vlieg*, who shows us his latest designs of heavy duty bed-type milling machines both for general purpose and for single purpose production.

It is in Jackson that we come across one of the few definite cases of welded steel machine tools. Through large special multiple drilling machines built recently by the *Fox Machine Co.*, have welded steel vertical columns and bases—the fabrication of these members having been accomplished successfully by the *Steel Plate & Shape Co.*, Detroit.

There is a development worth seeing at the *Wells Mfg. Co.*, Three Rivers, this being a large capacity metal cutting band saw, in which the action resembles that of a power hack saw frame. The band saw frame, pivoted at one end, is set nearly horizontal and is tilted to one side to clear the work by roller guides. The frame, swinging on its pivot follows the band as it passes down through the work.

At the *Atlas Press Co.*, in Kalamazoo, we see some highly significant developments in small lathes and drill presses which through extreme simplification and not through sacrifice of quality, can be sold at unbelievably low prices. These tools are successfully used on lighter manufacturing and do without question have a distinct place in today's machine tool picture.

The *Gallmeyer & Livingston Co.* in Grand Rapids is our next port of call. As an exponent of heavy duty surface grinding it has lately developed a powerful machine with one-piece frame and hydraulic feed, also a high-speed machine with fork-type head column. This latter machine has a 12 in. x 48 in. work table and a removable coolant tank with wheels and truck



**A**MONG the many special and production lathes produced by LeBlond, none is more generally popular than the LeBlond Regal. Introduced to meet the demands for an inexpensive metal-working lathe for hobbyist and small user, Regals soon found their way into the largest production shops because of their versatility; accuracy; ease, speed and economy of operation; dependability; ruggedness; their adaptability to a wide variety of jobs, large and small.

Made to LeBlond unexcelled standards of quality and precision, Regal Lathes have earned their place in industry through outstanding performance; giving maximum value per dollar invested. In your own manufacturing processes there is a place for one or more profit-making, cost-reducing Regals.



**CATALOGUE** of Regal Lathes in 10, 12, 14, 16 and 18 inch sizes will be mailed on request.

**The R. K. LeBLOND**  
**MACHINE TOOL CO., CINCINNATI, O.**  
 20 North Wacker Drive, Chicago    103 Lafayette St., New York  
**HALF CENTURY OF SERVICE TO INDUSTRY**

handle for convenience in emptying sludge and refilling.

From Grand Rapids we jump to Muskegon Heights where, at the shop of the **Morton Mfg. Co.**, the cutting action of draw-cut shapers is demonstrated. This company also has on its floor new models of keyway machines, slotting machines and horizontal boring, drilling and milling machines.

The terminal of our Ohio-Michigan journey is Big Rapids, where our objective is the **Hanchett Mfg. Co.** It is building hydraulic type heavy duty surface grinders up to nearly 18 ft. in length with belt covers which unroll over the ways as the table advances and roll up as it returns. In its shop we also see a 30 hp. vertical surface grinder using segmental or cylindrical wheels 20 in. in diameter over a 36 in. revolving magnetic chuck. This machine has Transitorq drive to the work table.

Back to Cincinnati, and then crossing the line into Indiana, our initial stop is at the **National Automatic Tool Co.**, in Richmond. As a builder of special purpose way drilling machinery, it always has something new "in the works." This time it turns out to be a six-way combination driller and tapper which perform 37 drilling, reaming, spot facing, chamfering and tapping operations on cast iron rear bearing retainers, at the rate of 60 pieces per hr.

On next to Indianapolis and the **International Machine Tool Co.** In its plant we watch the assembly of heavy duty turret lathes, the driving into place and final grinding of one-piece dovetailed hardened steel ways being particularly interesting. Here a test is made to show the complete rigidity of a new type of cross sliding main turret.

While in Indianapolis we also visit the **Millholland Machine Tool Co.** to see a special two-way double bank, piston finishing machine, equipped with four separate driving motors.

We stop off for a short time at Logansport, not exactly to see machine tools, but rather some things very closely related to them. The plant we visit is that of the **Logansport Machine Co., Inc.**, which is doing much for the machine tool industry by concentrating upon the development and manufacture for that industry of vital accessories such as air and hy-

draulic chucks, operating cylinders, valves and other power devices used in increasing numbers in modern production machines.

In South Bend, the **South Bend Lathe Works** is doing a commendable job in making high grade lathes available at moderate prices. This is done by mass production of the most essential types and sizes, on which much thought has been devoted to sensible design.

At Elkhart we call on the **Foster Machine Co.** Here we find what might be called "companion lines" of machine tools. While the main line includes high speed, precision ram and saddle turret lathes of universal type, there also are built the "Fastermatics." These are single spindle automatic chucking machines, some with flat platens, others with indexing turrets. These machines are useful either as sec-



# BROACHING Information . . .

Check the bulletins you would like to have. Clip this advertisement, attach it to your letterhead, and mail to **COLONIAL BROACH COMPANY, 147 JOS. CAMPAU, DETROIT, MICHIGAN**

Please send **BROACHING INFORMATION** indicated below

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| <input type="checkbox"/> High Speed Vertical Pull Type Hydraulic Broaching Machines             | <input type="checkbox"/> Single Ram Machines for Surface Broaching                  | <input type="checkbox"/> Power Presses for Heavy Duty Broaching                   |
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| <input type="checkbox"/> Universal Horizontals for Surface or Hole Broaching                    | <input type="checkbox"/> Heavy Duty Vertical Pull Type Hydraulic Broaching Machines | <input type="checkbox"/> Light Duty Presses for Light Duty Broaching and Assembly |
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Name \_\_\_\_\_  
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A complete line of standard broaching equipment to fit every broaching need.



Do you have our catalog Number 36 which gives the specifications of these cylinders as well as the six other standard styles of Non-Rotating Double Acting Air Cylinders? This catalog also includes detailed information on our standard and special air equipment.

**THE TOMKINS-JOHNSON CO., 628 N. Mechanic Street, Jackson, Michigan**

ond operation auxiliaries to the turret lathes or to fit into the production gap which often exists between turret lathes and multiple spindle automatics.

Having traversed the machine tool belt through Indiana, we now cross the line into Illinois, where our first business stop will be Chicago.

In Chicago we pay a visit to the *Armstrong-Blum Mfg. Co.*, which company has played an active part in the development of metal sawing machines from the wheezing, rattling power hack saws of 25 years ago to the rigid and powerful machine of this day of tough alloys. It has now developed a "rolling stroke" which simulates the fast cutting, chip freeing action of a carpenter's hand saw as it passes through stock. Its automatic production machine feeds accurately to length and cuts ten 6-in. gear blanks per hr. with no operating attention other than replenishing the stock now and then.

We find the *Hannifin Mfg. Co.*

busily engaged in working out for numerous machine tool builders new ways and means of applying hydraulic and pneumatic power and control to eliminate tedious hand operations. A large volume of this special equipment is going through the shop on its way to be built into a wide variety of machine tools.

*R. G. Haskins Co.* demonstrates to us a novel tapping machine in which the work is brought up to the tap by raising the work table by means of a foot treadle. The spindle operates up to 1000 r.p.m., with reverse speed double the tapping rate. The neat design of this machine is climaxed by enclosing the head and its drive in a cast aluminum shell.

We see at *Chas. H. Besly & Co.* the latest developments in disk grinders—powerful machines with special fixtures which will accurately finish opposite faces of castings "from the rough" in a few seconds.

Before leaving Chicago we pay a courtesy call on the *Illinois Tool*

*Co.* to whom the machine tool industry is indebted for the development and manufacture of gear charting machines, gear measuring apparatus and a wide variety of tools, cutters and broaches.

From Chicago we head direct for one of the great machine tool centers of America, the city of Rockford. Here are located nine companies of considerable size, also several smaller organizations.

A visit to the *Ingersoll Milling Machine Co.* gives convincing proof that machine tools can be to a considerable degree "standard," yet at the same time can be suited individually to meet the particular needs of every separate customer. Through use of a number of standard sub-assemblies, including Powerpak units, each Ingersoll machine is "tailored to fit" the work to be done upon it.

Significant developments here are: Combined stationary and portable central control stations; ways made from accurately finished (hardened and ground) steel tubing fastened to each side of the

# New 6" x 6" PEERLESS Improved HIGH DUTY METAL SAWING MACHINE

Automatically feeds the bar of stock forward to the gauge, automatically closes the vise, and automatically continues to repeat the complete cycle of cutting until the entire bar is cut to the length the gauge is set for, all without the attention of an operator.

The three speed sliding gear transmission—crankshaft—balance lever and trunnion blocks are fully ball bearing equipped.

The fastest cutting time possible at a minimum blade cost on any kind of metal because of its modern design and rigid construction. Also furnished without automatic bar feed.

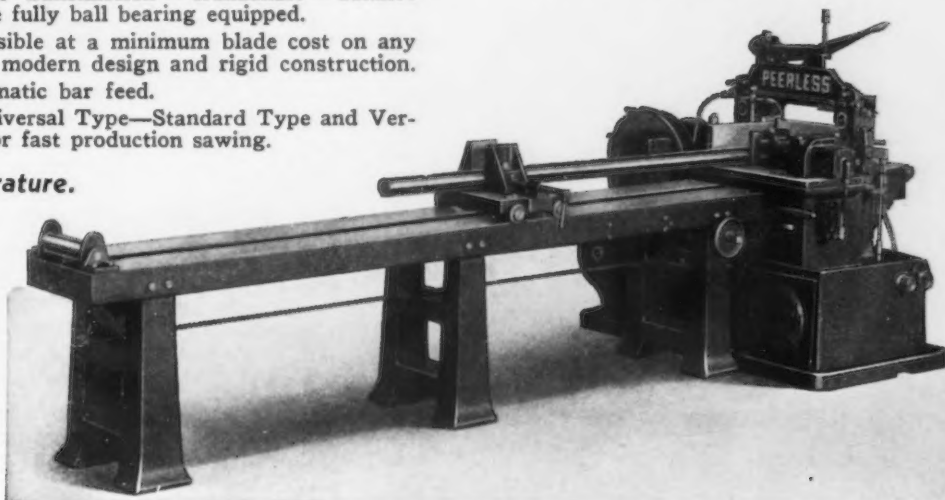
Also—Peerless Improved Universal Type—Standard Type and Vertical Type in various sizes for fast production sawing.

*with Hydraulically Operated  
Automatic Bar Feed*

*Write for complete literature.*

**PEERLESS  
MACHINE  
COMPANY**

RACINE, WISCONSIN



bed slide in semi-circular slots and lubricated by oil pumped in at the end and forced out through lateral holes; table rack—driven by a worm across the threads of which helical gear teeth are cut and which engage a helical drive gear in the bed; and built-in conveyers both of roller and of chain type.

We find that the *Sundstrand Machine Tool Co.* is introducing to the trade a system of hydraulic equipment for machine tool feed works and other industrial applications. The system includes a variable displacement pump giving two adjustable feeds and a constant displacement pump which provides rapid traverse—both being in a single housing, driven by a single shaft and together having only two revolving parts; a control valve; and a circuit designed to suit the application involved.

The Sundstrand "machine of the year" seems to have been the 32½ ton "Process Miller" for the simultaneous milling of six cylinder blocks. Through hydraulic and

electrical control, and with the help of protective devices and signal lights, one may operate this huge station type machine from a central station adjacent to the first milling operation. Blocks are fed into this machine from the shop conveyor, are shuttled through laterally and vertically, and finally are discharged upon the shop conveyor.

At the *Barnes Drill Co.* there is another striking example of construction from standard units. On a special base equipped with a hydraulic indexing table and chip sweepers, are mounted a set of all-gear self-oiling heads giving five working and one loading position. This assembly automatically performs a sequence of 7000 drilling, reaming and tapping operations per hr.

This company "takes its own medicine," in that holes calling for fine finish close fits, true alignment and fine finish are honed by the use of Sundstrand honing machines. For example, its hydraulic cylinders up to 10¼ in. diameter

by 31½ in. long are honed within plus or minus 0.0005 in. on the diameter and to straightness within 0.001 in.

We find that *W. F. and John Barnes Co.* recently has perfected a square ram hydraulic unit for high speed boring, reaming and related operations on small work. This unit's automatic cycle includes rapid approach, one or more rates of feed, controlled dwell and quick return.

Recent developments at the *Barber-Colman Co.* are concerned more particularly with cutting tools which do not fall within the scope of this review. The machine of most active interest to us on the occasion of our visit is that for taper splining—a development which should be of vital interest in connection with the building of other machine tools.

*Greenlee Brothers & Co.* shows us some improvements in its four-spindle automatics which permit quick change-over to be made from one job to another, thereby making short runs of work economical.

The machine has independent cross slides for each spindle and they are mounted on the vertical face of the head.

We find that recent developments at the **Rockford Machine Tool Co.** include faster and more powerful hydraulic shaper-planers of openside type, and also a double housing hydraulic planer. This

at the **Rockford Drilling Machine Co.**, where we see an interesting line of standard and special drilling, boring and tapping machines—including several of way-type; and at **Anderson Brothers Mfg. Co.**, where a demonstration is given of its power scraper, held and controlled as is a hand scraper, but with its fast power strokes ranging

find this company also assembling complete machines for drilling and allied operations.

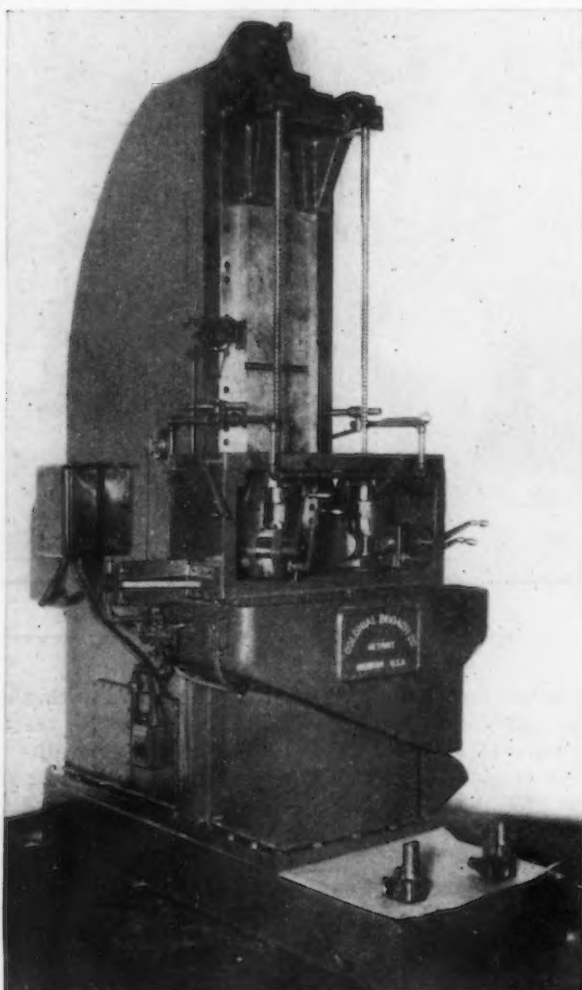
At Moline our objective is the **Moline Tool Co.**, whose specialty definitely is machinery for drilling and finishing holes, regardless of how many may be required in the work. It has machines with rows of spindles adjustable laterally, others with clusters of spindles adjustable in two directions. It has machines for counter-boring, for reaming and for tapping. There are still others for honing and for lapping.

While in Moline the logical itinerary is interrupted by a telegram calling for a quick trip to St. Louis, Mo., the "furthest west" machine tool center. There we call on the **Lehmann Machine Co.**, builder of lathes, gear lapping machines, oil groove milling machines, piston ring grinders and stoning machines. Its notable recent development is the Hydratrol lathe, to which a hydraulic system gives wide speed range, smooth power and easy central control. An "automatic slide rule," on the side of the headstock is coordinated with the operation of the speed-changing valve, thereby indicating the cutting speeds in ft.-per-min. for any diameter of work within the capacity of the lathe, and also the spindle speed at which it is running.

We also call on the **W. B. Knight Machinery Co.** to see an adaptation of its vertical milling machine by which it becomes a "jig-type" boring machine for repetitive work without jigs and fixtures.

Our regular itinerary is resumed, it now carrying us into Wisconsin, where Beloit is our first official stop-over. At Beloit we pay a visit to the **Gardner Machine Co.**, where we see new developments in production grinders both of disk and ring-wheel types. One is a double head machine with rotary work carrier, for finishing (facing) the crank ends of connecting rods, 0.010 to 0.015 in. of stock being removed. Among interesting attachments are mechanically oscillating swing arms and hydraulically operated knees.

And now on to Racine and a visit to **George Gorton Machine Co.**, from whose engraving machines has evolved a line of super-speed vertical milling machines for tool, die, mold and production work. The largest of these machines



o o o

**COLONIAL BROACH CO.** follows the trend toward simple lines in a machine which basically is one of straight-line motion. Broaching may be called "heavy-duty power filing" or it may be called "milling with longitudinal cutters"—depending on whether one is "filing minded" or "milling minded."

o o o

latter has a double length bed to eliminate "hand-over" of the table, box section housings shaped like the stepped or set-back towers in New York, and a cross rail of inverted "U" shape equipped with automatic hydraulic clamps. Other hydraulic features include table drive, tool feed and automatic tool lifters.

Our final calls in Rockford are at the **Mattison Machine Works** where we find that surface grinders indeed have "grown up" into high power precision machines for handling production on big work;

from a fraction of an inch to 4½ ft. giving great speed to an operation vital in the fitting and finishing of machine tool slides and other accurate parts.

We now resume our journey through Illinois, our next stop being at Freeport to call on the **Hoefer Mfg. Co., Inc.** Once again there is brought to our attention the growing importance in the machine tool industry of self-contained hydraulic feed units and multiple spindle drilling heads such as are furnished by Hoefer to other machinery builders. We

# AND HYPOID...

## *The Modern Gears for Big Drives!*

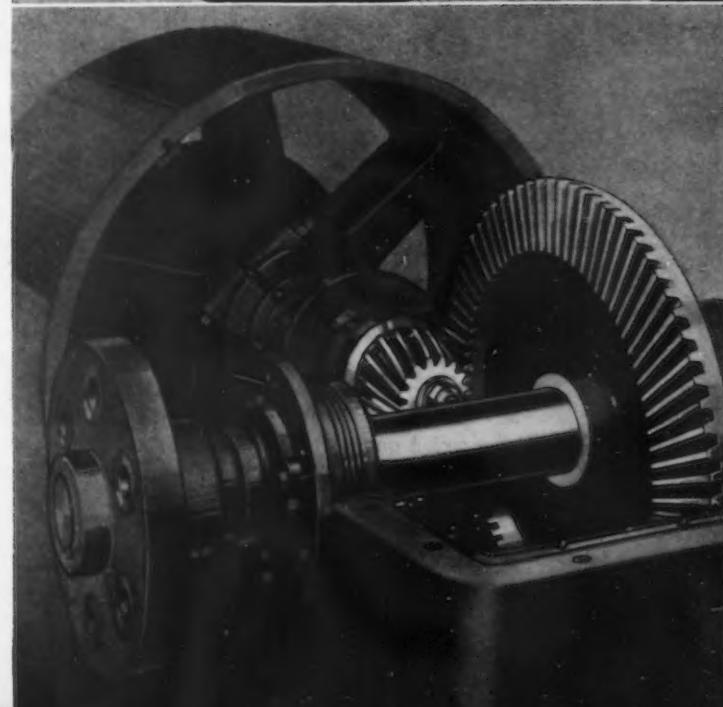
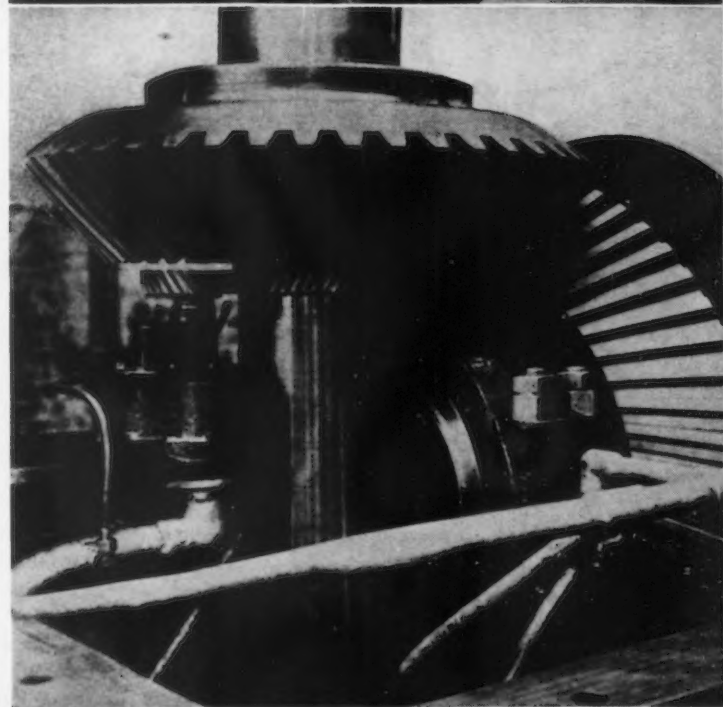
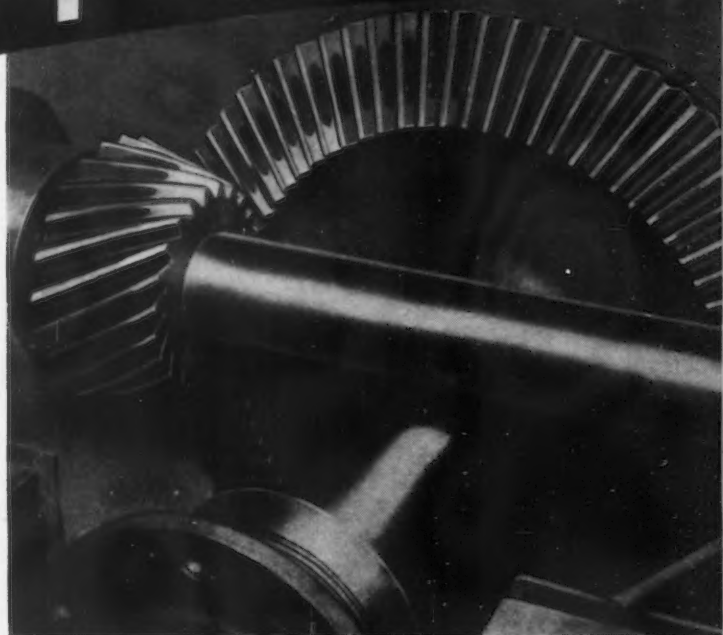
### **CURVED TOOTH**

Spiral Bevel and Hypoid Gears are displacing the straight tooth bevel in all types of large drives where smoothness and quietness of action are required.

These spiral bevel and hypoid gears have curved teeth which give a continuous pitch line contact, overlapping tooth contact, and localized tooth bearing.

Hypoid gears besides having the same smooth action have the additional advantage of non-intersecting axes which permit the shafts to pass.

The teeth of these gears are *generated* on Gleason Spiral Bevel and Hypoid Planing Generators. One such Gleason generator is here shown cutting a 98" spiral bevel gear for steel mill service. Please write us for further data about spiral bevel and hypoid gears, and the machines on which they are produced.

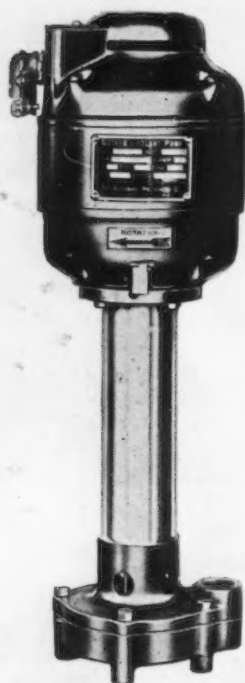


# GLEASON

1000 University Ave.

Rochester, N. Y.

# RUTHMAN GUSHER PUMPS..

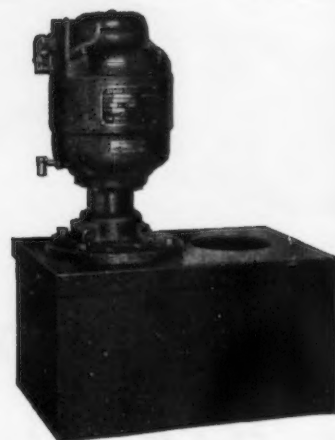


Model 'UL' Gusher Pump  
with Polyphase Motor.

have their bearings confined with the driving motor. There are no bearings, or metal contacts, within the Pump. There are no stuffing boxes required. These features enable them to handle water loaded with grit and abrasive materials both safely and economically.

**THE RUTHMAN MACHINERY CO.**

Cincinnati, Ohio



Tank Unit



Model 11021  
Immersion Type



Outside Mounted Type  
Model 11022

(maximum capacity, a 1 1/2 in. mill) has top speed of 4000 r.p.m., while the smallest (maximum capacity, a 1/2 in. mill) has top speed of 6300 r.p.m.

Racine gives an example of how a machine tool town is apt to become known for some distinct type of machinery. In this case it happens to be high speed, heavy duty metal sawing machines, in which the *Racine Tool & Machine Co.* and also the *Peerless Machine Co.* are recognized specialists.

We pay our respects to one other company before leaving Racine, this being the *Dumore Co.*, whose attachments for internal and external grinding on lathes, planers, shapers and other machine tool have brought the advantages of the grinding process to hundreds of plants which could not afford an investment in complete grinding machines.

And now we come to Madison, where we find that the *Gisholt Co.* lately has carried out an extensive program of reequipping and re-

arranging its equipment to afford more efficient manufacturing conditions. Recent developments include: An automatic spindle brake on the No. 4 turret lathe; a much simplified design of 18-in. turret lathe for fast production of the less complicated jobs; and a Simplimatic with radial slides for completely finishing Plymouth flywheels in two cam-controlled operations. A new style carriage gets the tools close to the work with little or no overhand.

Next on our Wisconsin program comes Milwaukee, where the *Kearney & Trecker Corp.*, long an advocate of attractive styling and full inclosure of drives and other equipment, lately has brought out a new heavy duty, knee type milling machine of particularly sturdy appearance, the driving motor being housed in the column.

The *Oilgear Co.*, one of the pioneers in the introduction of hydraulic systems for machine tools, has a number of "fluid power" refinements, resulting in from 100

to 600 per cent faster rapid traverse, and compensation for variations in feed due to temperature and working conditions. At the same time, simplification through redesign has made sharp cuts in the size and cost of the units, with operating efficiency as high as 97.6 per cent at 120 r.p.m. Units are built up to 100 hp.

At the *Stokerunit Corp.* we see several interesting applications of high speed boring units, including a boring machine for the average shop, which works to a tolerance of 0.0002 in.

Our last call in Milwaukee is at the *Delta Mfg. Co.*, where we are shown a line of very simple but thoroughly accurate and dependable drill presses of such moderate cost that even the smallest shop can afford them.

On our way to Fond du Lac, we make a stop at West Allis, where at the shop of *Grob Brothers* we watch the demonstration of a continuous filing machine, built along the lines of a band saw but using

instead of the band a "chain of files"—made up of a series of links having file-cut faces.

Our destination in Fond du Lac is the **Giddings & Lewis Machine Tool Co.**, where we find an interesting addition to the line which primarily consists of horizontal boring, drilling and milling machines of table type, planer type and floor type. Incidentally, some of these machines are so large that the operator rides in a cage literally on the tool, with an electrical control board at his finger tips.

The above-mentioned new development turns out to be a large multiple head planer-type milling machine which can be furnished with two, three or four vertical and horizontal heads. A feature is its directional control; that is, levers are arranged so that resulting motion of a unit in the machine is in the direction in which its control lever is pushed or pulled.

From Fond du Lac we continue on to Green Bay, where, at the **Cleereman Machine Tool Co.**, we see a new "tool room layout machine" of the vertical jig borer family, this one being intended for tool, die, jig and fixture work on which tolerances of 0.001 in. are allowable. Its fore-and-aft and lateral table traverse hand wheels carry graduated dials 8 in. in diameter, making for easy reading in setting.

Having now accomplished machine tool expedition number two, we make a quick return to Cincinnati, where we will lay out the itinerary for trip number three.

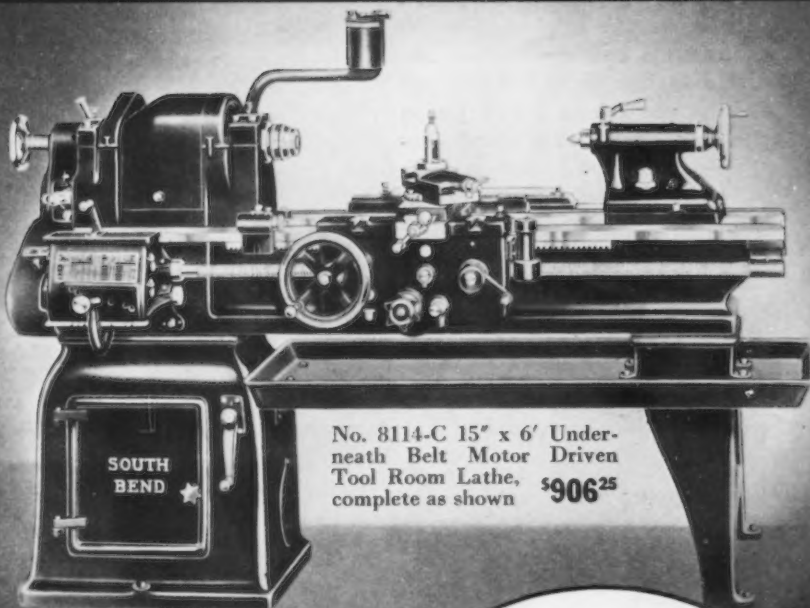
Trip number three—which is to be the last of our "inquisitive journeys through machine tooldom," or at least the last of this present series—will be the longest and most devious of all, penetrating as it does the older industrial districts of New York, Pennsylvania, New Jersey and New England.

We get off to a flying start, our first jump being a long one—to Erie, Pa. There we drop in at the **Rickert-Shafer Co.**, where we find a line of machinery which may be said to have developed around the self-opening threading dies and collapsing taps which are the specialties of this company. These machines include automatic machines for threading, tapping and second operations, which really are limited purpose automatic screw machines and cutting-off machines.

# NEW 1937

## SOUTH BEND Precision LATHES

Modern Lathes for Modern Industry



No. 8114-C 15" x 6' Underneath Belt Motor Driven Tool Room Lathe, complete as shown **\$906<sup>25</sup>**

9" TO 16" SWING  
PRECISION  
LATHES  
WITH DOUBLE  
WALL APRONS  
AND  
HARDENED  
STEEL  
SPINDLES

THE new 1937 Series, South Bend Lathes are recommended for the finest and most accurate work in the tool room, machine shop, manufacturing plant, and laboratory. Offered in sizes 9" to 16" swing, in bed lengths from 3' to 14', Motor Drive and Countershaft Drive.

Catalog No. 96 shows the new 1937 Series South Bend Precision Lathes in all sizes and styles. A valuable book for the shop man, engineer, and plant executive. Sent free, postpaid, upon request.

**SOUTH BEND LATHE WORKS**

592 East Madison Street  
South Bend, Indiana, U. S. A.

These prove how one line is apt to grow out of another.

We now jump to Buffalo where our first call is at the **Farrel-Birmingham Co., Inc.** There we see in action Farrel-Sykes machines which will generate any known type of herringbone, straight tooth and single helical gears both internal and external, to a wide variety of tooth forms and special contours, this in addition to

the Sykes continuous herringbone gears.

Our other call in Buffalo is at the **Buffalo Forge Co.**, where—despite the implications of the company name—we find in production a complete line of upright drilling machines, including high speed ball bearing types, both single and multiple spindle.

Rochester—our next stop—is very definitely a machine tool cen-

ter. Calling at the **Gleason Works** we are impressed with the broad field to which the spiral bevel gear generators are now applied. In one case we see one of these machines cutting a gear of 3/16 in. pitch diameter, in another case one of 100 in., in other words gears from instruments to rolling mills. In the No. 16 machine greater flexibility of setting minimizes cutter requirements and a simplified calculated system speeds the set-up. We also are shown a new pinion rougher with variable speed gen-

Co. we find William S. Davenport, after nearly 50 years of experience with high speed screw machines, still finding new ways to split seconds on his five-spindle automatics. Specialization has been carried to a high point in this shop, concentration being upon one size of one model, designed for a wide variety of special tooling.

Two companies in Rochester are specialists on small, fast machine tools. **High Speed Hammer Co.** has developed a sensitive precision drilling machine which has maxi-

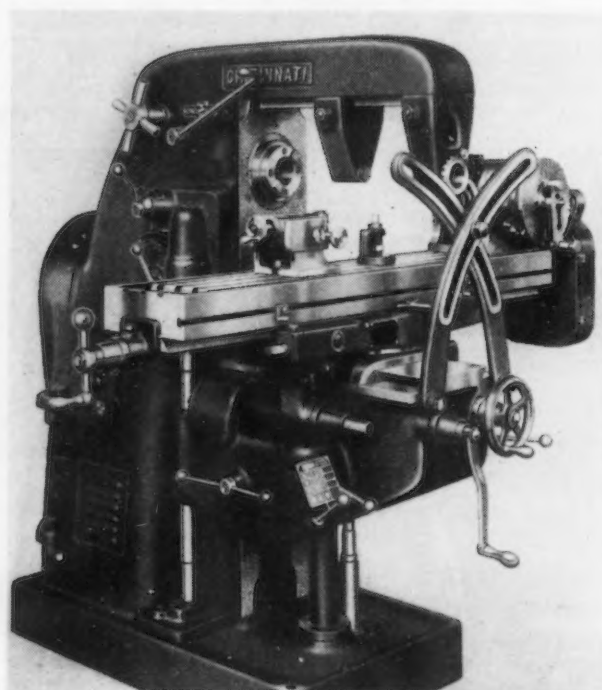
**Cable Machine Co.**, in Syracuse, where a development of much significance is the "electric head" built into the Carbo-lathe. A Compact box above and integral with the head carries a panel on which are starting and stopping buttons for all the motors, pressure gages for the pneumatic or hydraulic system, and direct-reading ammeter. These ammeters, by indicating the amount of power being consumed, enable the operator to maintain proper feeds and speeds for maximum production with safety to tooling equipment, and to detect electrical trouble before damage occurs. This head also permits the department supervisor to check operation at a glance to forestall excessive tool breakage. This is especially desirable in shops operating on a piece work or premium basis.

A stop is made in Elmira, at the shop of **Hardinge Brothers, Inc.**, which is in production on improved Cataract bench lathes featuring fully enclosed headstocks and spindles equipped with pre-loaded ball bearings.

We now find ourselves in Pennsylvania where our first business call is at the **Landis Machine Co.** in Waynesboro. There we see a number of interesting applications of threading by the use of opening dies, the action of which must literally be instantaneous to keep in step with the tremendously quick motions of the automatic machines on which so many of them are used.

At the **Landis Tool Co.** there have lately been several significant developments of which we are informed during our Lancaster stop-over. For instance, we see a real mirror finish put on a large roll in one of its roll grinding machines in the design of which much thought has been given to rigidity and to proper distribution of weight. This particular machine, which has a hydraulic work carriage and multiple V-belt drive, is equipped with special bearings for the wheel. They are of steel, babbit lined, and are fitted with extreme care.

The size of some of the roll grinders is quite astounding. One recently built by the Landis Tool Co. is of 60 in. swing and 312 in. between centers, its wheel head alone weighing nine tons. This huge machine, which will handle a 75-ton roll, has 113½ hp., subdi-



THE modern knee-type milling machine probably has the widest range of adjustments of any standard type of tool. In spite of this, rigidity is preserved at all adjustments, and controls are kept convenient to the operator. This is the new Cincinnati No. 2-MH machine for small to medium work.

erating motion which equalizes tool wear and prolongs tool life, and a completing generator which both roughs and finishes differential gear and pinion teeth at one handling.

Of the many machines constituting the diversified line of the **Consolidated Machine Tool Corp.**, a special lathe for rough turning 3½ in. 40-50 carbon bars 30 ft. long is of particular interest. This machine turns these bars from end to end in 5½ min. Another special development of Consolidated is a Newton high production milling machine with four cutter heads and a revolving drum type work fixture. This powerful machine lends itself to ready retooling if the product is changed.

At the **Davenport Machine Tool**

Co. we find William S. Davenport, after nearly 50 years of experience with high speed screw machines, still finding new ways to split seconds on his five-spindle automatics. Specialization has been carried to a high point in this shop, concentration being upon one size of one model, designed for a wide variety of special tooling.

We now move on to Seneca Falls. At the **Seneca Falls Machine Co.** there is on the floor an automatic Lo-Swing lathe equipped with triple tool slide, designed for machining axles held between centers. There also we see the "Imp," an extremely simple automatic for simple work such as turning bushings held on an arbor. This machine is equipped with a magazine and a loading and unloading device, and requires very little operating attention.

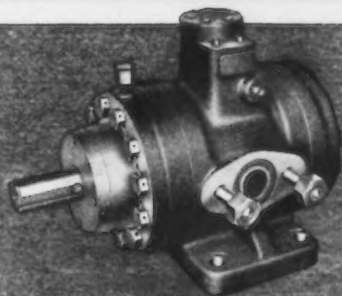
Our next call is at the **Porter-**

## for all kinds of machine tools

### A new line of hydraulic feeds and controls



**VICKERS** Balanced Vane-Type Rotary Pump for continuous working pressures up to 1000 lb. per sq. in.; nine capacities from 2 to 100 g.p.m.



**VICKERS** Balanced Vane-Type 2-Stage Rotary Pump for pressures to 2,000 lb. per sq. in.



**VICKERS** Combination Pump and Valve Unit delivers large volume at low pressure and small volume at high pressure.



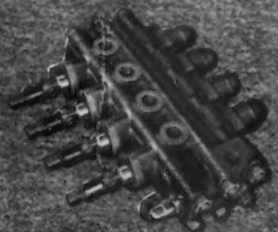
**VICKERS** Electric-Hydraulic Control Panels are available in several types and sizes.



**VICKERS** 3-, 4-, 5- and 6-Way Valves are available with many modifications including manual, latch, pilot or solenoid operation.



**VICKERS** Balanced-Gear Fluid Motor provides efficient and compact variable speed rotary drives.



**VICKERS** Multiple Unit Valves used extensively for road building and maintenance equipment.



**VICKERS** Hydraulic Relief Valve (Balanced) for pressures to 5,000 lb. per sq. in.



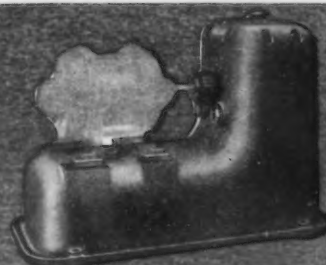
**VICKERS** Hydraulic Variable Speed Transmission used for wide variety of rotary drives.



**VICKERS** Motor-Pump consists of either 1,000 lb. or 2,000 lb. series Balanced Vane-Type Pumps flange mounted on either single or double end ball bearing electric motor.



**VICKERS** Feed Control Valve provides positively controlled rate of flow not affected by changes in operating pressure or back resistance. Available in many capacities.



**VICKERS** Oil Reservoir and Motor Base includes Balanced Vane-Type Pump and Relief Valve.

Practically any required feeds and sequence of motions (manual, semi- or full automatic) can now be secured by using various arrangements of standard Vickers pumps, valves, control panels, etc. This results in greater flexibility, interchangeable parts and lower costs.

Vickers engineers will be pleased to work with you in the application of efficient and dependable hydraulic feeds and controls to your machine tools and other equipment.

Write for information and bulletins descriptive of above or other items in which you may be interested.

vided among nine motors ranging from  $\frac{1}{4}$  to 60 hp. each. Control is centralized at an operating platform on the traveling wheel carriage. Wide strip steel, which makes possible the latest automobile body construction, owes its existence very directly to modern roll grinders.

Our final call in Lancaster, which obviously is quite a machine tool center, is at the **De Walt Products Corp.**, where we watch the demonstration of a high speed cutting off machine of circular saw type. This has an automatic feed which consistently results in blanks accurate in length to 0.005 in.

And now on to Philadelphia, one of the oldest machine tool centers in the United States. At **William Sellers & Co., Inc.**, we find that a system of unit construction has greatly simplified the production problem attending the manufacture of three types of precision horizontal boring machines. All three—that is, table type, planer type and floor type utilize the same compact unit head. In an operating test of one of their new table type machines we notice that four strategically located selective levers control the entire machine—spindle, head, table and saddle—while a single “Start-and-stop” lever takes care of the entire machine.

Our congratulations go to Peter Hall, president of the **Hall Planetary Co.**, to whom was awarded in 1936 by the Franklin Institute of Philadelphia, the Edward Longstreth Medal “—in consideration of his invention and development of machine and cutters for planetary milling and threading.”

At the **Frew Machine Co.** we notice on the assembly floor, among such machines as cam millers, profiling machines and duplex drillers, a number of relatively simple hand millers. It is demonstrated to us that on small single work, high production can be attained on these machines, the operators getting to know by the “feel” exactly how much the tools will stand.

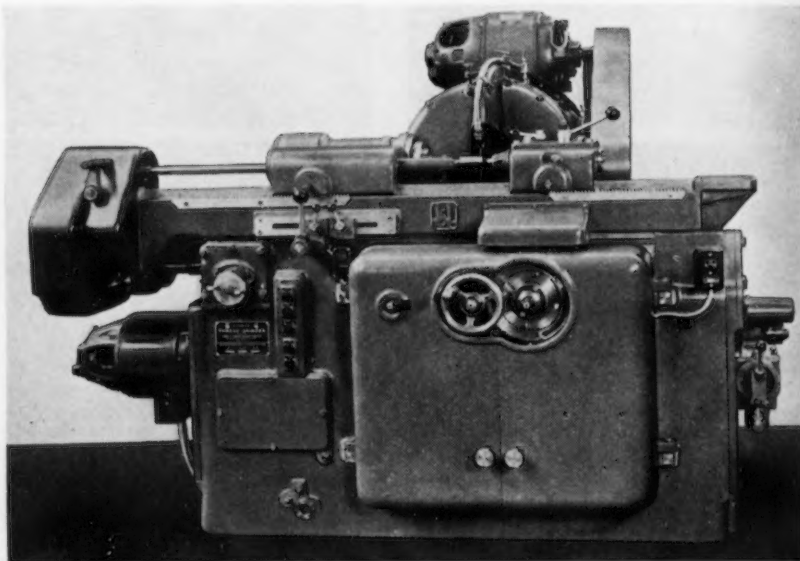
En route from Philadelphia to Newark we stop off at Plainfield, N. J., where at the **Walker-Turner Co.** we see another one of those very low priced drill presses which has been developed to the point of being thoroughly practical

for light, continuous production work.

And so to Newark or rather to nearby Irvington, for a call on **Could & Eberhardt**, one of the oldest machine tool companies. Fred L. Eberhardt, a son of one of its founders, is president and general manager, and is an “elder statesman” of the industry. He was one of the original members of the National Machine Tool Builders’ Association when it was founded at the turn of the century and 30 years ago he began his two terms

**Bullard Co.** we see ingenious tooling set-ups whereby the capabilities of the large Mult-au-Matic vertical multiple station chucking machines are increased through use of auxiliary slides and other attachments. There also are new developments in smaller machines of this type. A trend toward higher speed, increased tooling capacity and grouped controls is plainly indicated in the design of their latest spiral drive vertical turret lathe.

One of the recent developments at the **Producto Machine Co.**,



**D**EVELOPED originally for grinding of taps the capabilities of this Jones & Lamson thread grinder have been increased to handle a wide range of commercial thread grinding. It is an interesting fact that this machine literally grew up around a unique method of dressing the wheel to exact contour. This dressing takes place after each pass over the work.

as its president. Experience of three generations of Eberhardts in the theory and practice of gear cutting is exemplified in their latest machines, including hobbing machines, rack cutting machines, and disk-type gear cutters of single spindle, multiple spindle and special turret type.

And now the time has come to penetrate New England, the cradle of the machine tool industry in America and still the locale of a great many machine tool building organizations several of which have been in existence for more than a hundred years.

Passing through New York City, we enter Connecticut no farther than Bridgeport before we strike machine tool building. At the

typical of those inspired by automotive requirements, is a **Producto-Matic** designed for milling locating pads on automobile crankshafts preparatory to the center turning of their bearings in special production lathes.

At the Andrew C. Campbell division of **American Chain Co., Inc.**, which we visit primarily to see the nibbling machines, we get an unexpected demonstration of its Hudorkut submerged cutting machine. All cutting is done with the work immersed in the coolant, the resulting cuts being so clean and smooth that no further finishing of the cut face is required.

We find at the **Baird Machine Co.** a number of interesting tooling developments on its multiple



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Two-fisted production executives will recognize immediately the advantages made possible by the many new Monarch features . . . a few of which include: Nickel steel headstock gears—hardened, with ground teeth; more anti-friction bearings than any other make; automatic force feed lubrication throughout; industry's only all-hardened steel lathe; anti-friction bearing taper attachment— $6\frac{1}{2}$ " per foot taper easily turned or bored. Full details in two new Monarch catalogs now just off the press. Write for your copies.

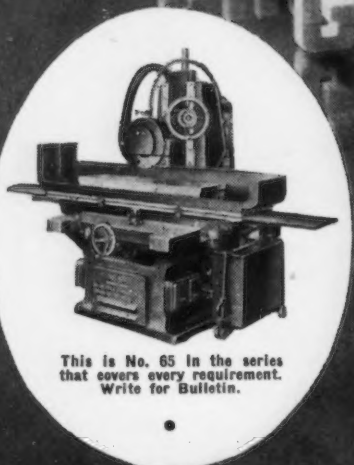
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25 years experience is built into these high speed precision, hydraulic feed, surface grinders

**GALLMEYER & LIVINGSTON CO.**  
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spindle automatic chucking machines, both horizontal and vertical. One in particular is one whereby parts up to 10½ in. in diameter can be finished on centers.

Capabilities of modern grinding machines to do work requiring removal of a considerable amount of stock are demonstrated at the **Bridgeport Safety Emery Wheel Co.** The horizontal spindle face grinder on which the demonstration is made is a rugged, powerful production machine, with hydraulically driven table of large capacity. A segmental wheel is used.

Our last two calls in Bridgeport are at the **Automatic Machine Co.**, where we are shown diamond tool boring machines, both single and multiple spindle; and at the **Bodine Corp.**, where recently developed automatic dial-type drilling and tapping machines operate with such speed that one gets the impression that the work is being punched rather than drilled and tapped.

Next we make the short run to New Haven, where in the suburb

of Whitneyville the foundations of America's machine tool industry were laid by the famous Eli Whitney about 130 years ago. Today the industry is represented in that city by two companies which—though primarily manufacturers of automatic threading tools for use by other machine tool builders—do in each case build threading machines. These companies are the **Eastern Machine Screw Corp.**, and the **Geometric Tool Co.**, both active members of the National Machine Tool Builders' Association.

Distances between industrial centers up here in New England in many instances are very short and almost before we realize it we are at the plant of the **Farrel-Birmingham Co.** in Ansonia. The extent to which roll grinding is practiced today is driven home to us when we see on the erecting floor such machines ranging from 24 in. by 8 ft. up to 60 in. by 26 ft. roll capacity.

At Meriden we stop long enough at the **Packer Machine Co.** to look over its 14 head polishing

and buffing machine. It has 38 work-holding fixtures mounted on a conveyor chain which moves between the heads. Drive to spindles is through Transitorq. While this has all the earmarks of a special machine, it actually can be set to take care of a wide variety of work.

We immediately encounter Transitorq again at the **Hendey Machine Co.** in Torrington. We find the device built into its Hi-Speed step turning lathe, the speed changing device being controlled by a small hand wheel beside the headstock convenient to the left hand of the operator.

Our next port of call is New Britain where on the assembly floor of the **Goss & De Leeuw Machine Co.** we observe a striking illustration of the advantages of strict interchangeability in machine tool parts. The parts and sub-assemblies of their tool revolving and work revolving multiple spindle automatic chucking machines, being made to close limits through use of a complete system of jigs, fixtures and gages, go together with none of that cutting and trying and fitting which characterized machine tool assembly not so many years ago.

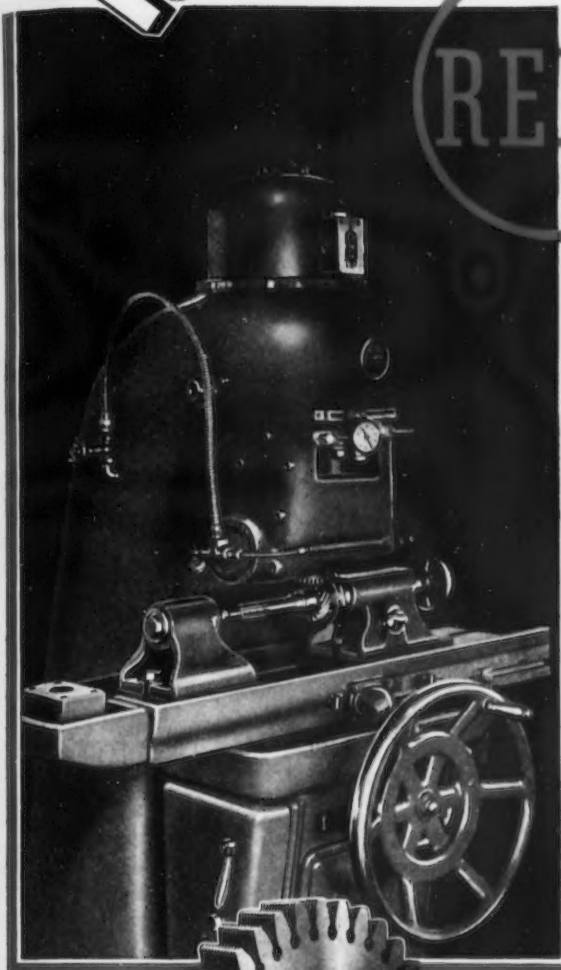
Our other call in New Britain is at the **New Britain Machine Co.**, where pleasant memories still linger of the late Christopher M. Spencer, originator of the automatic screw machine. The New Britain-Gridley division of this company lately has developed improved lines of four- and six-spindle automatics, built on the same main frame. Freedom from spindle carrier wear is attained by a mechanism which automatically lifts it from its working seat as it indexes and then clamps it tight while the cutting is going on.

Another feature is an automatic electric stop whereby the cycle of the machine is halted at loading position, with collet open, when stock in any spindle is used up. In case a butt end is left in the spindle the last full piece is completed before stopping, a signal light in the meantime warning the operator that the machine needs attention.

We push on to Hartford and to the Pratt & Whitney plant which during the past year became the **Pratt & Whitney division, Niles-Bement-Pond Co.** Congratulations to Clayton R. Burt are in order not

# REDUCE GEAR FINISHING TIME TO SECONDS

## RED RING ROTARY CROSSED AXIS GEAR SHAVING MACHINE



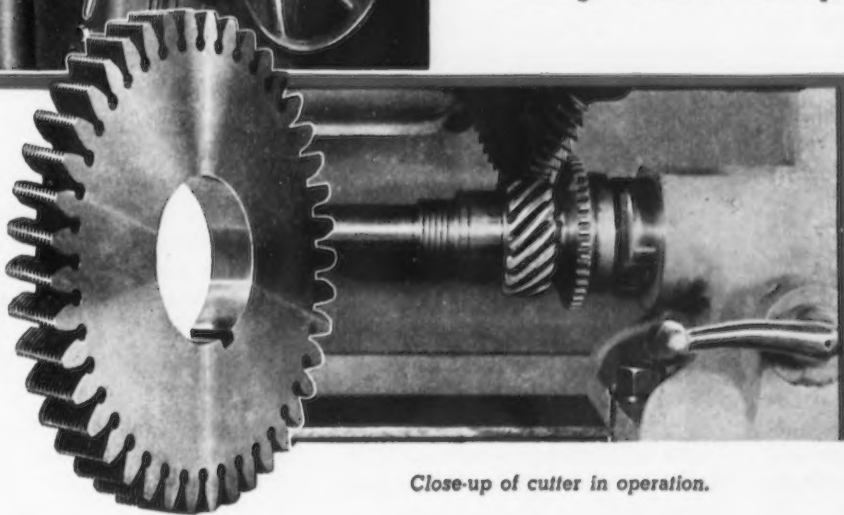
Higher speed . . . better finish . . . characterizes the work of the Red Ring Gear Shaving Machine. It will finish a 20 tooth gear, 9.25 pitch, 20° pressure angle, 35° helix angle, in 20 to 40 seconds floor to floor, depending on the stock to be removed. Other gears are handled with corresponding speed.

Profile . . . index . . . eccentricity . . . and helix angle are corrected to high precision. Profile, for example, is brought to within 0.0001" of true involute. Surface of teeth is rendered bright and smooth . . . no squeal when such gears are run at high speed.

The machine employs limited crossed axis shaving at high speed. The cutter is a helical gear with gashed teeth. Fast cuts at slow feed . . . resembling fly cutter work . . . are taken as the cutter runs in mesh with the work gear. Action is cutting . . . not burnishing. No metal is compressed to rebound in heat treatment.

Write for complete data on the Red Ring Shaver. It produces better gears at considerably lower cost.

Enlarged view of gashed cutter. Cutter life of 35,000 to 75,000 work units is normal expectancy.



Close-up of cutter in operation.



Chips full size and magnified four times to show clean cutting action.

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SHOEMAKER & ST. JEAN DETROIT, MICHIGAN

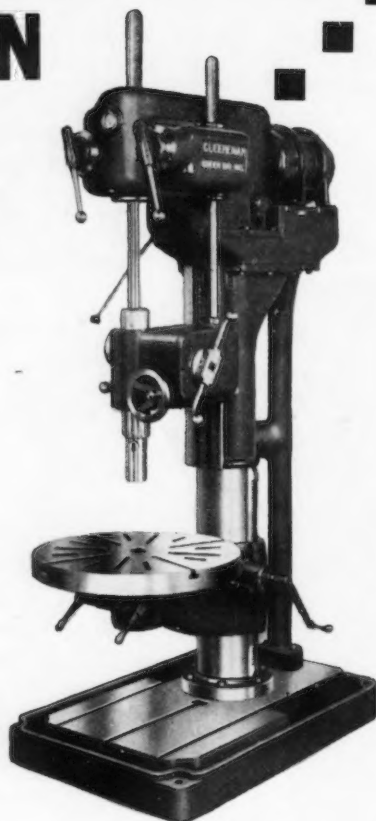
# CLEEREMAN DRILLING MACHINES

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FULLY GEARED  
ANTI FRICTION  
AUTOMATIC OILING  
SINGLE LEVER  
CONTROL FOR FEED  
SINGLE LEVER  
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**THE CLEEREMAN MACHINE TOOL CO.**  
GREEN BAY, WIS.



out by its heavily gibbed sliding overarm—also swivels from vertical to horizontal, cutting at any angle.

At the *Bausch Machine Tool Co.* we find that there was built in 1936 one of those colossal machines which play so important a part in automobile manufacture. This one is a five-station, drum-type, double end, multiple spindle, horizontal opposed drilling machine. It weighs 73,000 lb.; its right hand fixed center head contains 48 spindles; its left hand fixed center head has 40; it has 310 ball bearings and 230 roller bearings; and its 68 hp. is divided among five motors. Handling from 55 to 60 cylinder blocks per hr., this machine finishes from the rough all valve and tappet holes and also core drills the thrust and four water holes.

Still headed up the river, we arrive at Greenfield, stopping at the *Production Machine Co.*, where a recent development is a high speed, centerless feed, polishing machine for cylindrical work. Its feed is automatic and a device trues the wheels while they are in action.

Our next jump, still up the valley of the Connecticut, is a comparatively long one, taking us into what might seem to the uninitiated literally the "backwoods of Vermont." Springfield, Vermont, the third of the "machine tool Springfields" met with in our travels, is indeed unique among machine tool centers—located as it is in a rural section of hilly country several miles off the main line steam railroad. It is none the less an important machine tool town.

There we find the *Jones & Lamson Machine Co.*, which through several changes in name and one change in location dates back more than a hundred years. This was the first company to build commercial turret lathes and after about 80 years of turret lathe experience it continues to be one of the leaders in that field.

The machine that grips our interest on this occasion, however, is not a turret lathe. It is an automatic thread grinding machine just put on the market after many years' experience in tap grinding. This machine may be said to be designed around a wheel-truing device by which—with no attention on the part of the operator and

only upon his election as president of the Niles-Bement-Pond Co. but also upon his election as president of the National Machine Tool Builders' Association, honors and responsibilities which came to him in 1936.

In a line as diversified as that of Pratt & Whitney it is a bit difficult to select from many new developments a few for special mention in this limited space. There is the new Keller tool room machine whose 12 in. by 10 in. range is sufficient to cover a great majority of punch and die work and plastic molds. There is the vertical shaper, set up to machine cylindrical surfaces through use of a revolving and indexing table. There is the high speed vertical miller and profiler in one and two-spindle models. There is the Cam Lock spindle nose, standard on Pratt & Whitney lathes after rigorous shop tests since 1932. There is the new precision lathe having 40 ball bearings, those on spindle and lead screw being of extra high ac-

curacy. There is the 10 in. by 20 in. precision bench lathe with Transitorq drive.

At the *Taylor & Fenn Co.* we find ourselves among duplex spline milling machines and vertical milling machines which drive their small end mills at such speed that they seem fairly to melt their way through the work. Here also we see demonstrated the ease of control given to an internal grinder by the hydraulic system.

In addition to precision thread milling machines we are interested at the *Hanson-Whitney Machine Co.* in the possibilities of its new universal tool and die shaper as an effective means of cutting blanking dies.

From Hartford we push on up the Connecticut River to Springfield, Mass., another of the three "machine tool Springfields." A visit to the *Van Norman Machine Tool Co.* brings to our attention the unusual range and flexibility of its No. 32 milling machine on which the cutter head—adjustable in and

without disturbing the size adjustment to which the machine is set—the 20-in. wheel constantly is kept sharp and true in thread form throughout its useful life. This machine will grind threads up to 8 in. in diameter and 9 in. long on parts up to 31 in. long.

Walking over to the nearby plant of the **Bryant Chucking Grinder Co.**, we note the broadened field of bore grinding. On one hand we see a small automatic machine for fast production on bearing rings, rolls, gears, and other small bore work. Incorporated in this machine is an automatic sizing device which—one might say—is an “automatic inspector.”

Then on the other hand we see machines of similar basic design, but capable of handling heavy jobs up to 31 in. swing, these large machines being hydraulic. There also is a double spindle machine of 16 in. swing. This wide range reflects increasing use of hardened parts in mass production and the ever-tightening tolerances on commercial work.

At the **Fellows Gear Shaper Co.** it is evident that there always is something new in the theory and practice of gear cutting and that such trends are promptly reflected in gear shapers, their cutters and apparatus for checking gears. For example, there is demonstrated to us a new method of cutting internal gears up to 2½ in. in diameter, by the use of a “gap-type” cutter in a gear shaper equipped with timing relay which stops the machine with cutter gap in position to allow unloading and loading. Gears are roughed out and finished by the same cutter, part of whose teeth are ground for roughing and the rest for finishing.

In addition to regular and super-speed gear shapers, we see generators for straight and hour glass worms; burnishing machines; lapping machine; automatic cutter grinders; and a gear testing machine which draws a graph showing the condition of a gear. We also are shown special tooling for generating cams, segments, helical splines, etc.

And last but by no means least, the Fellows enveloping gear generator which working at speeds up to 1000 surface ft. per min., cuts and burnishes simultaneously. A 24-tooth 10-pitch gear of 1-in. face



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The new Internal and External Contour Saw made the part illustrated in the exceptional time noted.

This is only an example of the astonishing savings from the new cutting process that saws, files, polishes.

Find out how the DO-ALL CONTOUR method can speed up your production as it has in Aircraft, Auto, Electric, other Industries, through its controlled mastery of metal.

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can be finished by this method in 25 seconds. The enveloping cutter has teeth conjugate to those on the work, but meshing only when the axes are askew. Cutting edges intersect faces of the teeth, extending in planes traverse to the axis. When tool and work in contact rotate under pressure, divergent travel of the teeth causes the cutting edges to take a light shearing cut while surfaces back of the cutting edges do the burnishing.

An automobile ride of less than 20 miles over the Vermont hills brings us to Windsor, where machine tools have been built for more than a hundred years and where Jones & Lamson Machine Co. originated. Here we visit the **Cone Automatic Machine Co., Inc.**, builder of multiple spindle automatic screw machines and chucking machines. Here we see the largest standard four-spindle bar machines—capable of handling bars and tubing 6 in. in diameter, and here also we see eight-spindle bar machines of revolving head (indexing) type.

Here in Windsor we find that a group of machine tool men lately have launched a new project—the **Windsor Automatic Co., Inc.**—and are just putting on the market their Di-Matic. This is a two-spindle, non-indexing automatic

screw machine designed to handle the simpler types of formed, turned and drilled work. Being easy to tool for short runs, it is intended to fill the production gap between single spindle machines and the more elaborate multiples.

From Windsor we drop down the valley of the Connecticut for a short distance and then drive over the mountains to Keene, New Hampshire. Here we find a most unusual case of diversification at the **Kingsbury Machine Tool Corp.** One division of this company manufactures sturdy mechanical toys of pressed metal; another division manufactures units and complete machines for production drilling, tapping and milling. By its method of construction with standard self-contained units, machines can be suited to seasonal demands in production, and can be completely rearranged when necessary to suit a completely redesigned product. A typical example of one of its machines is a multiple driller for the numerous spoke holes in bicycle hubs.

From Keene we descend the mountains and go on down to the ocean at Boston. In the Brighton district we call at **Rivett Lath & Grinder, Inc.**, where there is demonstrated to us the surprising production ability and extreme ac-

curacy of a new bench lathe with roller bearing spindle, fully enclosed head and multiple V-belt drive from a motor and speed box unit which gives a range of spindle speeds from 200 to 2300 r.p.m.

Over in Cambridge we visit the **Blanchard Machine Co.** As an example of production that can be attained on its latest vertical spindle surface grinders, we will mention an achievement on small bearing race rings in one of its No. 16-A automatic grinders. These parts are loaded in multiple rows onto a continuously revolving magnetic chuck which carries them under the constantly adjusted "saucer-type" wheel and then are discharged at the opposite side through a demagnetizer. Production is 6000 pieces (12,000 surfaces) per hr.

From Boston we go on to Providence where we visit the **Brown & Sharpe Mfg. Co.**, another famous machine tool building organization which is over a century old. Its line of machine tools is widely diversified and with many improvements it is a bit difficult to pick its "machine of the year." Our final decision goes to the full electric milling machine, in which specially developed driving and control apparatus is completely built-in—all this in a rugged machine of wide capabilities and extremely pleasing lines. Precise control of cutter and table is possible on this machine, and the ordinarily difficult feat of "climb milling" is accomplished with no difficulty whatsoever.

Another achievement of 1936 has been the redesign of hand screw machines and automatics. There now is higher ratio between low and high speeds, the speed of the small automatic having been "upped" 20 per cent — to 6000 r.p.m.

In Providence we also drop in at the **Diamond Machine Co.**, specialist in production grinding machinery, whose line includes face grinders, surface grinders, pulley grinders and disk grinders. There have been many developments lately in this field, particularly in work holding fixtures for special jobs.

In nearby East Providence we call at the **Abrasive Machine Tool Co.**, whose president and general manager, Norman D. MacLeod,

completed his successful term as president of the National Machine Tool Builders' Association in the fall of 1936—his term being the 35th anniversary year of the association and quite definitely the year of renewed hope in the industry. The Diamond achievements during 1936 can be covered by this simple statement "—to make surface grinders more versatile." That, by the way, neatly sums up the 1936 achievements of nearly every machine tool builder, that is, the "more versatile" phrase does.

Located in the adjoining city of Pawtucket is the **Potter & Johnston Machine Co.**, whose principal line is one of automatic chucking and turning machines on the turret lathe principle. Significant developments here, as in many shops during 1936, are along the lines of special tooling and adaptation of the machines to a wider range of work.

From Pawtucket we drive on to Hudson, Mass., which is a "two-bell" machine tool city—home of the **Universal Boring Machine Co.** and of the **Lapointe Machine Tool Co.** At Universal we are impressed with the ever-increasing demands made upon builders of large horizontal boring, drilling and milling machines for extreme working accuracy and at the same time for high power cutting and rapid traverse of table and head. In the new machines these demands have been met, but not without a great concentration of engineering thought and recourse to the latest materials and machinery building methods.

As an example of a 1936 achievement in broaching, the Lapointe people show us their automatic broaching machine with indexing mechanism. On this machine, 80 involute splines are broached in the hub of a cast steel tractor drive gear. The size of this special machine can be judged by the fact that the tractor gears are 37½ in. in diameter and weigh 400 lb. The length of the cut in the hub is 6 in., the hole having ¾ in. per ft. taper.

And now on to Worcester, Mass., one of the outstanding machine tool centers. Here at the **Heald Machine Co.** (another company which began business more than a hundred years ago and still is run by its founding family) there have been numerous developments dur-

ing the past year. We will attempt to "high-spot" only a few of them. Point number one is that every one of its machines shows the desirable effect of good "industrial styling." For instance, the numerous guards which safety demands, not only give safety but also are designed so that they blend into the design as a whole, making the machine an "ensemble," not just a "pile of parts."

Among the grinders, some of internal centerless type have been developed to handle work where holes must be absolutely concentric with outside diameter or rather with periphery. Work is supported between a regulating roll, a supporting roll and a pressure roll (all with antifriction bearings); grinding is done by a wheel at the end of a long rigid spindle; and a diamond pointed finger gives readings of size. There is an internal grinder of gap type for work up to 38 in. in diameter by 15 in. long. In this machine an "accordion cover" shields the ways in the gap when the bed is run back to open it. The work guard operates hydraulically, getting out of the way to allow handling of work by crane.

Among the Bore-Matics is one designed for boring automotive cylinders or other large work up to 9 in. bores 16 in. long, as many as eight holes being bored simultaneously. This machine, which weighs 11,000 lb. has its table at shop conveyor level for convenience in loading and unloading.

Over at the **Norton Co.**, Howard Dunbar, manager of the Grinding Machine division, demonstrates to us what the latest semi-automatic cylindrical grinders will do. These machines, ranging in capacity from 6 in. by 18 in. up to 10 in. by 48 in., can be equipped for: Automatic cycle, hydraulically operated; automatic work drive control; automatic wheel head advance; automatic grinding wheel feed; automatic or manual sizing control to stop or to indicator; automatic or manual dwell period for size or finish; automatic wheel head traverse; and automatic power table traverse. Choice of features depends upon the work to be done and the preference of the customer. Inasmuch as the machines are interchangeably built on the unit system, the particular

units required can quickly be assembled to give a machine possessing the capabilities called for.

Mr. Dunbar also describes to us a Cam-O-Matic machine which at one setting grinds 12 cams and an eccentric on Plymouth cam shafts. Each cam makes eight revolutions in contact with the grinding wheel, the wheel leaving the cam "at the nose" each time. As each shaft is finished the grinding wheel is trued automatically before the table stops in loading position. Production is 13 camshafts, representing 169 individual grinding operations per hr.

When we ask friends at the **Reed-Prentice Corp.** that old familiar question, "What's new?", they immediately point with pride to the Newall automatic thread grinder, of which they began the manufacture in 1936. This is a horizontal machine suitable for taps, gages, special bolts and any other precision threaded work. A series of light cuts are taken at high speed, strains in hardened work thereby being released gradually, the consequent errors being corrected by subsequent passes of the wheel. Pitch is controllable with 0.0001 in. This machine has a unique diamond wheel truing device based on the pantograph idea, a projector being employed to obtain an enlarged profile of the diamond from which the stylus is made.

Reed-Prentice engineers also have developed an improved vertical miller and die sinker of 21 in. by 12 in. by 16 in. capacity, with spindle speeds up to 4000 r.p.m.

Our last two calls in Worcester are at the **Arter Grinding Machine Co.**, and at **O. S. Walker Co., Inc.** Arter is covering the field of small and medium sized work—that of the automobile industry particularly—by a complete line including: Rotary surface grinders; automatic piston ring grinders; automatic head and end piston grinders; automatic angle wheel grinders; automatic cylindrical grinders; and magnetic chucks.

O. S. Walker is more than just a machine tool builder. As primarily a designer and builder of magnetic chucks of about every conceivable size and variety, it is his job to cooperate with other builders of machine tools—grinding machines in particular. Thus he has

played a part in many machine tool developments in 1936. Beyond all this, he is a machine tool builder in his own right, by virtue of his vertical spindle rotary chuck production surface grinders and his tool grinding machines.

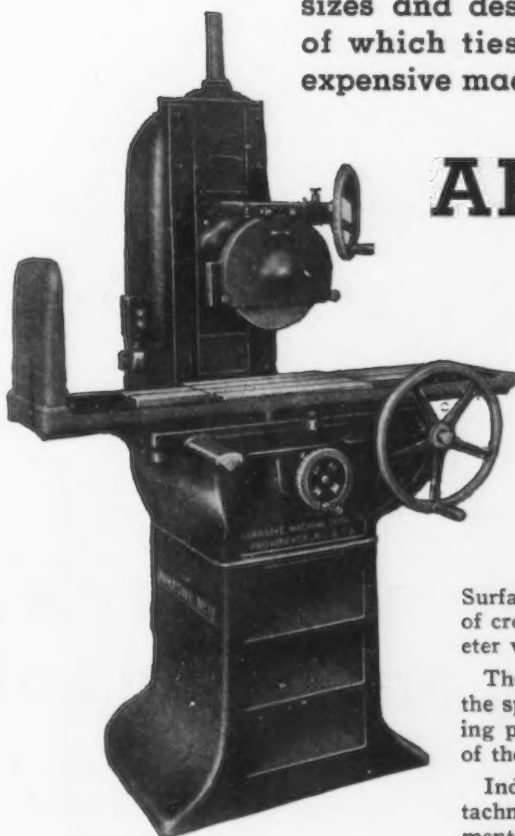
By the circuitous route through New England, which we laid out for personal as well as business reasons, we finally conclude our "grand tour" of the American machine tool industry at the town of Barre in the hills of central Massachusetts. Our business reason for coming here is to call at the **Charles G. Allen Co.** Here under the engineering and manufactur-

ing supervision of Mr. Allen and his sons there has been developed a well-known line of ball bearing equipped high speed drilling and tapping machines for small work under production conditions. There also is fresh air and there are winter sports in Barre, and a chance to relax.

And so we "rest our case" with this final comment. No longer can the machine tool industry be called conservative. It has within a few short years snapped out of its traditional lethargy, to become one of the most "sensible progressive" key industries in America today—and the most typically American.

## THIS IS THE ANSWER!

How to take care of those innumerable one and two piece jobs of all sizes and descriptions, the grinding of which ties up larger and more expensive machines.



### ABRASIVE NO. 1½ SURFACE GRINDER

A hand operated machine, easy to operate, sensitive and as accurate as your micrometer. The capacity of this machine is 50% greater than the usual small Surface Grinding Machine. Ten inches of cross-feed and 12" under a 12" diameter wheel!

The motor being mounted directly on the spindle saves the use of other moving parts and assures the transmission of the full power of the motor.

Individual Motor Driven Exhaust Attachments or Wet Grinding Attachments can be supplied as accessories with these machines, also Magnetic Chucks, Demagnetizers, Vises and Dial Indicators.

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## ABRASIVE MACHINE TOOL CO.

EAST PROVIDENCE—RHODE ISLAND

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## ▲ No. 10 Plain Milling Machine

—a new **electrically controlled** production unit for the rapid manufacture of small parts, combining many of the proved design features of the successful new design No. 12 Plain Milling Machine . . . and many advanced construction features of the increasingly popular "Light Type".

## ▲ No. 0 Omniversal Milling Machine

—redesigned to incorporate an omniversal milling head that can be used on the side of the machine or in either of the overarm locations—**added** versatility for this unique machine tool.

## ▲ No. 2 Wire Feed Screw Machines, Motor Driven and Overhead Driven

—new in design with new features that make these semi-automatic machines more profitable on short runs or second operations, due to higher spindle speeds—broader range of work—high ratio between high and low speeds.

## ▲ No. 00 Automatic Screw, Turret Forming and Cutting-off Machines

—redesigned to provide for increased spindle speeds to 6000 R.P.M. and increased capacity to  $\frac{3}{8}$ " dia. ( $\frac{1}{2}$ " for light work), giving maximum production regardless of the material.

# BROWN &

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# SMALL TOOLS AND GAGES

*Better machine tools have  
necessitated better cutting  
tools to keep pace with them.  
To-day, we have the best  
in both.*

By FRANK W. CURTIS

*Manager, Firthite Division, Firth-  
Sterling Steel Co., McKeesport, Pa.*

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• • •



BECAUSE of the constant demand to remove metal faster, without sacrificing accuracy, small-tool development continues to occupy a rather prominent place in the metal-working industries. Not many years ago, a cutting tool did well to remove 5 lb. of metal per min. Today, a tool of modern design can easily remove 20 lb. or more per min. This contrast is important because it clearly indicates the very definite trend of tool engineering, a normal condition brought about by the demand

to produce larger quantities at less cost.

The economic importance of small tools is quite evident when we consider that a cutter costing but a few dollars might be working in a machine that costs several thousand dollars. If the cutting tool is incorrect, or if it lacks strength so that its weaknesses are reflected on the surface of the part being machined, then all the fine accuracy of the machine tool itself is wasted.

A cutting tool weighing but 2 or three lb. may work in a machine that weighs 2 or 3 tons, yet that little tool might be the cause of heavy losses if it lacks some necessary qualification. Small tools, therefore, should not be considered from a standpoint of price first, as is so often the case, but more on a basis of quality and service. The

cost of a tool is really the last consideration—performance is by far more important.

Speed is a big factor today, not only the speed with which metal can be cut, but the speed with which finished parts can be produced within a given degree of accuracy. For this, we turn to the small tool to offer the utmost in cutting ability. Its quality must be beyond dispute.

During the past year, progress of cutting tools has been very steady. No revolutionary development has taken place, yet small tools, as a whole, are better today than they were a year or more ago. Tool manufacturers have directed their attention to four factors: (1)—Better cutting materials; (2)—Increased cutter strength; (3)—Improved hardening methods; and, (4)—A wider range of cutter de-

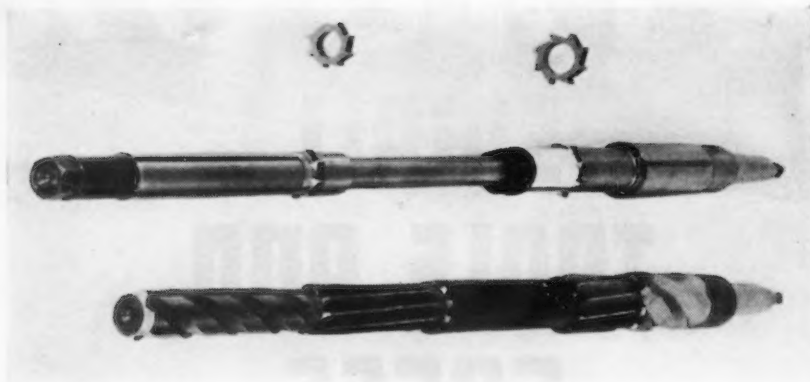


FIG. 1

**P**ACKARD-TYPE disk reamer at top. Standard reamer is shown at bottom for comparison.

signs. Together they have contributed to further tool economy.

Better cutting materials are the result of research on the part of steel makers, but tool manufacturers, naturally, endeavor to use materials that will enable the user to get the most favorable results. So far, the standard forms of high-speed steel, known as the 18-4-1 type, and the super high-speed, or high-cobalt type, remain the preference for most cutting operations, excepting where sintered carbides can be used.

Several new or modified types of tool steels have been developed of late, but either results have not warranted their use in preference to the commonly used standard types, except in limited applications, or else developments have not progressed to a point where their qualities are fully known. For example, steels with a high molybdenum content are in process of development, as are high vanadium (18-4-2 and 18-4-4) and copper-boron type tool steels.

Cutter design has played an important part in small tool development. Strength has been more carefully considered so that teeth and cutting edges hold up better. Quite often, this has been accomplished by modifying the shape of the tooth or the blade itself. Then, too, certain tools have been made shorter, or more of the stub type, so that weaknesses can be overcome. Of particular interest is the effort made to avoid deflection by reducing overhang so that tools will cut without vibration or chatter, two common causes of rapid dulling. Much has been learned about tool support through carbide tool practice which calls for the utmost in rigidity, all of which is equally

applicable to cutters made of tool steels.

As for hardening methods, improvements have also been somewhat general. Temperature control



FIG. 2

**A**t the center is shown a 1-inch disk type reamer with replaceable disk.

remains important to offer uniformity and for this better heat-treating equipment is available. Different types of treatment for steel seem to attract interest. No

doubt there is chance for improvement in this direction. One tool manufacturer, through heat treatment, has been successful in making relieved tools, such as thread hobs, so that finish grinding of the form is unnecessary because no decarburization or scaling takes place on the surface during hardening. In other words, the tooth form is machined carefully to a shape that is maintained during treatment so that no additional finishing is required. Cutter life is not sacrificed, but on the other hand is said to be considerably increased.

The design of small tools has been engineered to meet specific conditions so that a much wider range of operations can be handled more effectively. Particular attention has been paid to special tools because quite often through their use it has been possible to combine two or more operations into one, or to machine several surfaces together with a greater degree of accuracy. The advantages of special tools, under certain cutting conditions, are so great that enormous manufacturing economies are effected through their use.

### Solid Type Tools

A departure from the traditional solid-type reamer, made by substituting a thin disk in place of the usual fluted design, is a recent development in small tools which has economic advantages. It was originated by the engineering department of the Packard Motor Car Co. and is being used for many reaming operations in the automotive industry. A representative example is shown in Fig. 1, which illustrates the comparison between the fluted-type and the newer disk-type reamer used for finishing the distribution-shaft hole of automotive cylinders. Aside from accuracy, the outstanding gain, which is evident, is the reduction in cost

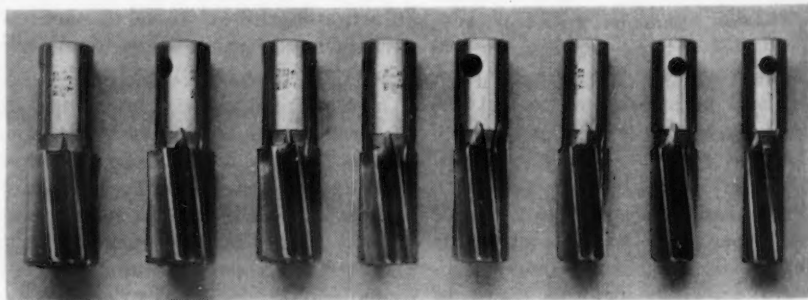


FIG. 3

**W**HERE stub reamers are applicable, tool cost is reduced nearly one-half.

of the disks compared to fluted reamers. The thickness of the disk is made in relation to the diameter of the hole to be reamed. The ratio is about 10 or 12 to 1. For larger holes the disk is made thicker than

sizes in Fig. 3. While basically developed for automatic screw machine operations, they find a broad field in reaming parts suited to short tools, as might be handled in drill presses or hand screw ma-

duces the hazards of breakage, while at the same time they are capable of excellent performance and long life. One of these reamers in use is shown in Fig. 4 finishing an accurate running-fit hole in a V-belt pulley. The reamer is made with left-hand spiral flutes, producing a smooth, true hole.

With the advent of tougher and harder materials, which have a decided preference in some products, toolmakers have developed cutters of one kind or another that are particularly suited to this class of work. Usually, they are made of high-cobalt steel, such as Circle C, and are given a very accurate heat

treatment to insure uniform hardness and toughness. A representative example is the P & W "Blue Helix" reamer illustrated in Fig. 5. These reamers are specially treated to cut steel alloys that brinell 375 or more, while the operation shown is that of reaming a 12 per cent silicon-aluminum part of an aircraft motor, the abrasiveness of which is known to be quite severe on cutting tools. In this direction, carbide tools have had a wide influence in the use of harder mate-

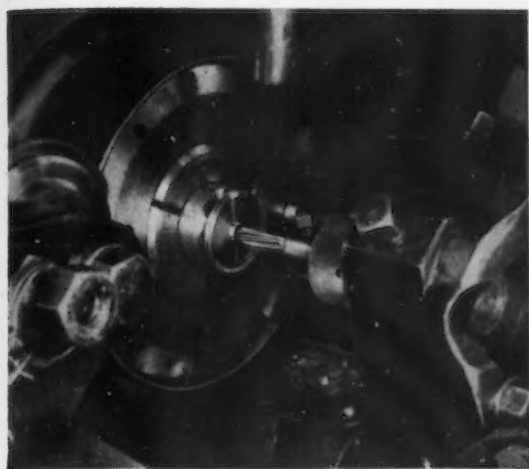
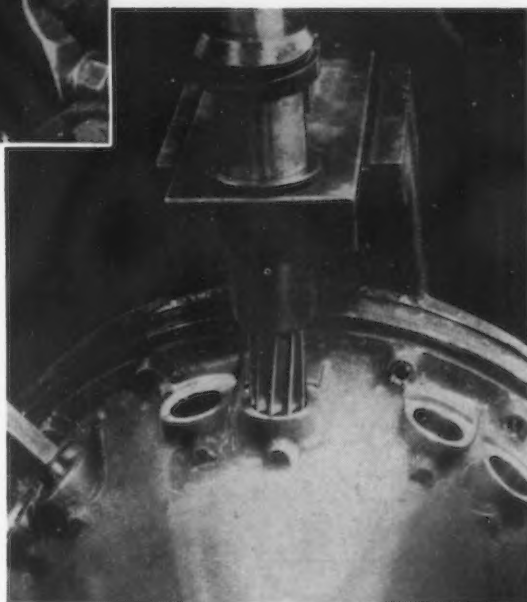


FIG. 4 AT LEFT  
A STUB reamer with left-hand flutes making a smooth hole in a V-belt pulley.

FIG. 5—BELOW  
P&W "BLUE Helix" reamer for use on hard or abrasive materials.



disks used for small holes. The disks are usually made with eight teeth, which are unevenly spaced and which have the face of the cutting edges set either radially with the centerline of the reamer or slightly back of the radial center.

In Fig. 2, at the center, is shown a 1-in. reamer of the disk type. At the left may be seen the replaceable disk, while at the right is shown the former fluted reamer which has been eliminated by the newer design.

Since the cost of the disk is comparatively small, it is possible to have several on hand for a given operation, which is not always the case with the shell or solid-types. With properly designed arbors, the disks can be changed quickly so that the downtime of a machine, necessitated by cutter changes, is small. Tests have indicated that extreme accuracy can be maintained and that there is a comparable life expectancy. The hole range for reaming is from about 1/2 to 2-in. diameter. These disks are made of high-speed steel for the majority of operations, but they lend themselves quite favorably for tipping with carbide inserts on certain classes of work, which improves their performance since smoother finishes and a longer tool life are made possible.

Another form of small tool representative of economy is the stub-type reamer, shown in various

chines. The stub reamer is much shorter than that of standard design and its cost is almost half. Those shown, made by Pratt & Whitney, can be used in solid or floating holders. By applying a pin through the hole in the shank a simplified form of floating holder can be made inexpensively. The use of a shorter reamer often re-

duces the hazards of breakage, while at the same time they are capable of excellent performance and long life. One of these reamers in use is shown in Fig. 4 finishing an accurate running-fit hole in a V-belt pulley. The reamer is made with left-hand spiral flutes, producing a smooth, true hole.

Special holders or arbors often play an important role in the design of small tools where two or more cuts are to be taken at one time. Rather than using a solid one-piece tool, which may be expen-

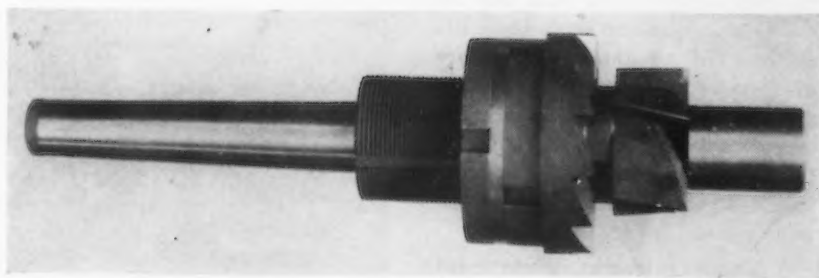


FIG. 6  
MORSE multiple-facing and counterboring tool with independent, individual cutter adjustments.

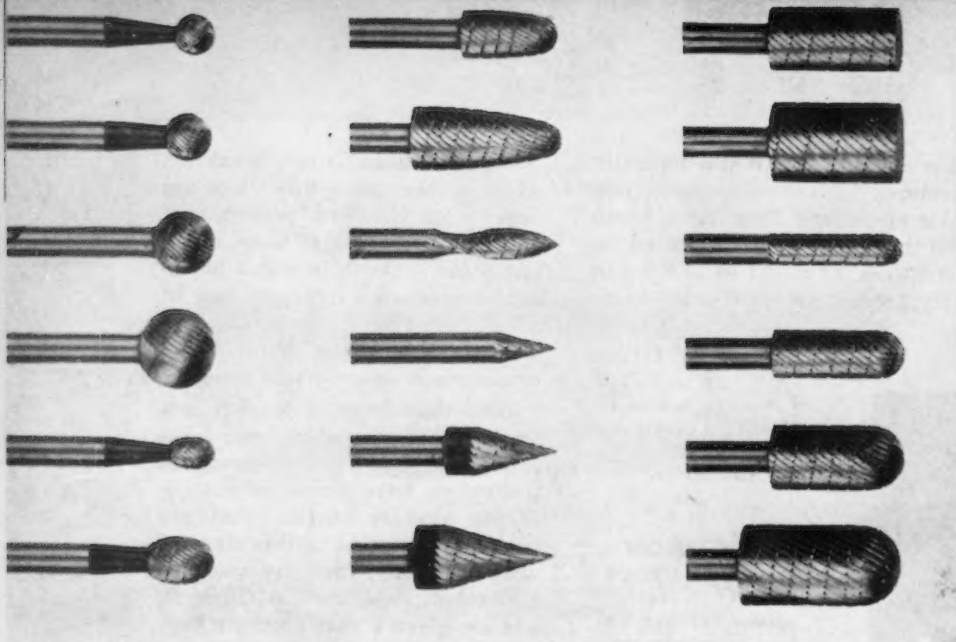


FIG. 7  
**T**EEETH are ground from the hardened blanks for these Jarvis rotary files.

sive, it is better, when possible, to revert to the use of individual cutters, mounted integrally on a single holder, and to have independent adjustment to compensate for wear, which might vary considerably. An example of such a multiple tool, made by the Morse Tool Co., Detroit, is shown in Fig. 6, and is used for counterboring and facing purposes. Each tool section has individual adjustment so that it is not necessary to sharpen one section any more than necessary, or in direct relation to one another as would be the case if the design were of the solid type. In fact, combination tools of this kind permit changing of single cutters only as they become dull, and leaving the others in use to serve their life cycle. The advantages are more pronounced when there is a wide difference in diameters, since the larger tools are more likely to become dull quicker than those of smaller diameter when run at the same speed.

A somewhat recent development in the design of rotary files developed by the Charles L. Jarvis Co. is shown in Fig. 7. Instead of making these files with the usual procedure, that is turning them to size, cutting the teeth and then hardening, they are made by first forming the shape, then hardening, and finally grinding the teeth from the solid hardened blank. Tests from files of this kind have shown that they cut somewhat faster and offer a longer life in contrast with the usual milled, or hand-cut file.

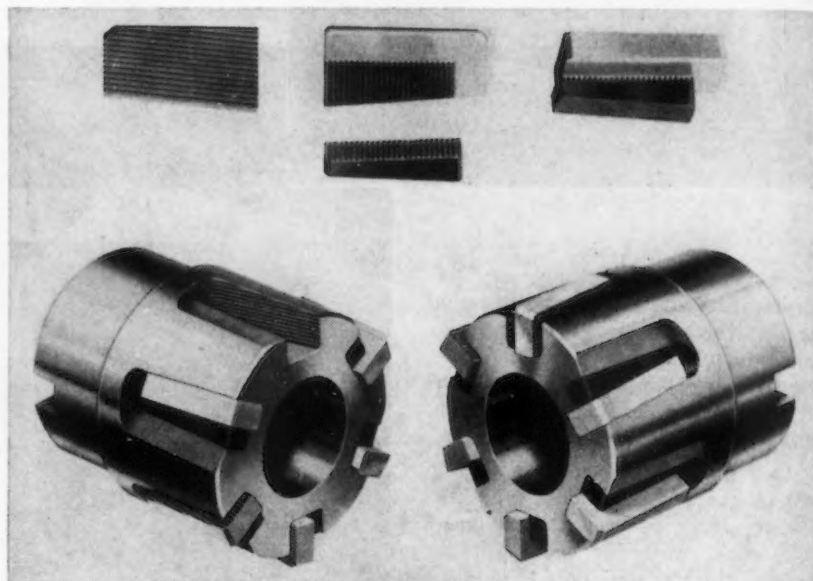


FIG. 8  
**K**ELLY shell reamer with inserted blades.

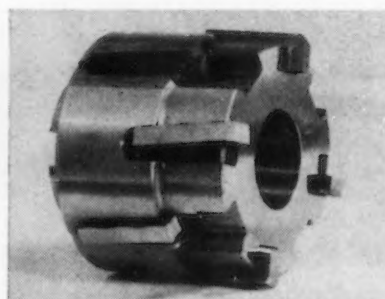


FIG. 9  
**M**ULTI-DIAMETER shell reamer of same construction as that in Fig. 8.

In grinding these files from the solid, the shape of the teeth has been improved so that chatter is practically eliminated. Another feature is that these files can be reground when they become dull.

Multiple inserted-blade tools such as reamers, milling cutters, spot

facers and counterbores, find preference over solid-type tools wherever they can be used because of their economy. This has led to a number of improved methods for the holding, locking and adjusting of blades into the body. Simplicity of design and ease of adjustment rule in this direction. Economical blade life is also of importance and has been well considered, the purpose being to arrange the design so that a greater portion of the blade is usable.

A shell-type reamer with serrated blades embodying several advantages and made by the Kelly

Reamer Co., is illustrated in Fig. 8. This tool has only three component parts, the body, blades and wedges. The blades, in combination with the wedges, are of the

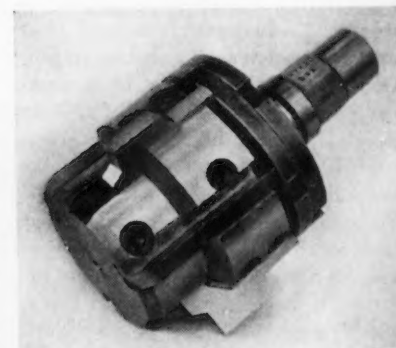
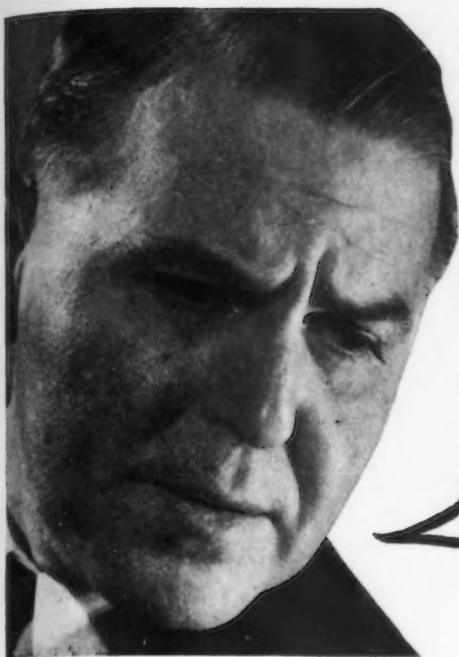


FIG. 10  
**M**ORSE multiple-blade cutter of inserted tooth type for facing and chamfering rear axle housing ends.



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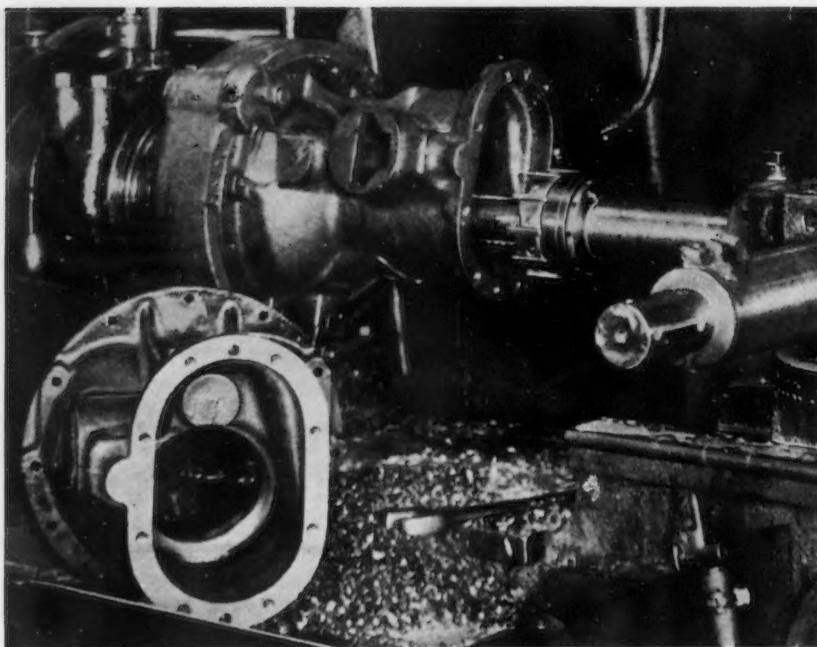


FIG. 11

**P**ILOT bar used with McCrosky reamer on malleable iron carrier.

self-locking type. Assembly is accomplished by placing a blade and a wedge together in their correct relation and then inserting them into the slot opening of the reamer body, driving them to a tight seat. The blades are held against both radial movement and endwise movement by means of radial and longitudinal serrations. Blade adjustment in small increments is attained by changing the relation of the contacting wedge one serration in either direction as may be required.

A multi-diameter tool embodying the same construction is shown in Fig. 9, which is representative of how this design lends itself to a rather wide field.

A representative example of a multiple-blade cutting tool, made by the Morse Tool Co., for boring, facing and chamfering the ends or rear-axle housings, is illustrated in Fig. 10. This tool is provided with inserted blades which can be quickly adjusted to compensate for wear. The design of the tool is so made that the sharpening of the various cutting edges may be performed in the usual style of tool grinder without removing the blades. The body of the tool, as may be seen, is of heavy proportions, so that the blades receive rigid support, thus insuring maximum life between grinds.

In using small tools, it is well

to remember that when proper attention is given to rigidity, accuracy is not so difficult. The more rigid the set-up, the more accurate will be the cut to be made. This rule works both ways, therefore, any weakness in a tool will be reflected in the cut, or the poorer the set-up, the less accurate will be the finish. An example of an accurate finish reaming operation made possible largely by well piloted and heavy-duty bar is shown in Fig. 11. It illustrates a McCrosky shell reamer with high-speed steel blades mounted in an automatic turret

lathe, for finish reaming malleable iron differential carriers. The spindle is operating at 100 r.p.m. with a feed of 0.062 in. per revolution. The reamer diameter is 4.625 in. and the total tolerance allowed on the finished hole is less than 0.001 in.

The use of inserted-blade Firthite-tipped reamers for finishing valve holes in aircraft cylinder heads, made of cast silicon-aluminum, is illustrated in Fig. 12. The operation is performed by reaming both holes at one setting at right angles to each other, using P & W Camlock serrated-blade reamers. A small piloted-type solid reamer is used in combination with each reamer for the larger holes. These solid reamers, however, are made of high-speed steel and are fastened integrally with the bodies of the inserted blade reamers. Due to the wide range in diameters, the combination of tool steel and carbide-tipped reamers worked quite effectively on this set-up, both of which operate at correct corresponding speeds.

Milling continues to be a favorite means of finishing a wide variety of surfaces, which has been the direct result of many developments in both the solid and inserted-blade type cutters. The so-called high-powered cutters, having fewer teeth of stronger design, are more in evidence, especially in view of the newer milling machines which make their use more general. Inserted-blade cutters, while basically the same, have been improved to the extent of being made sturdier

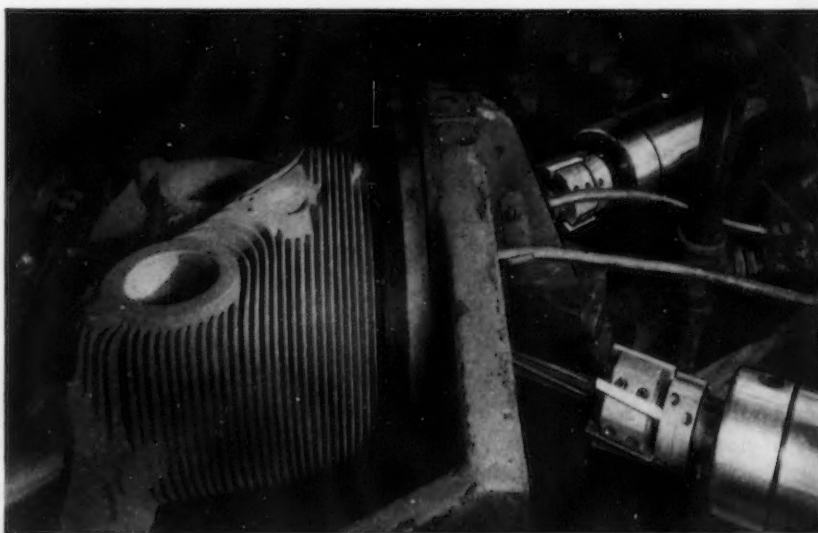


FIG. 12

**F**IRTHITE tipped inserted blade reamers finishing valve holes in aircraft cylinders.

# Dependable/ Low Cost Metal Cutting



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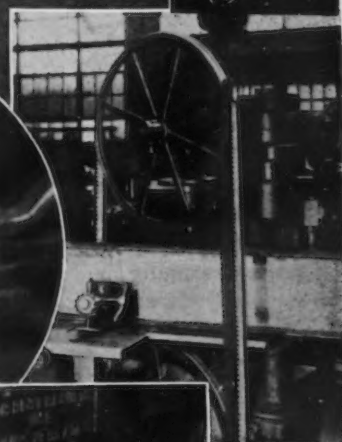
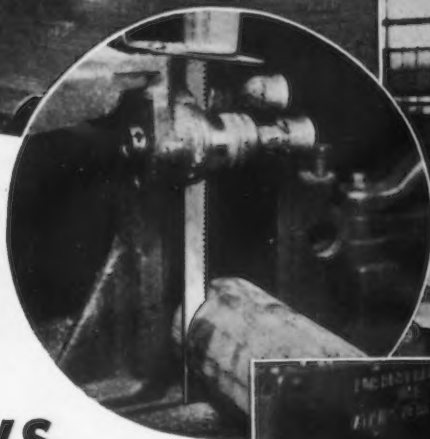
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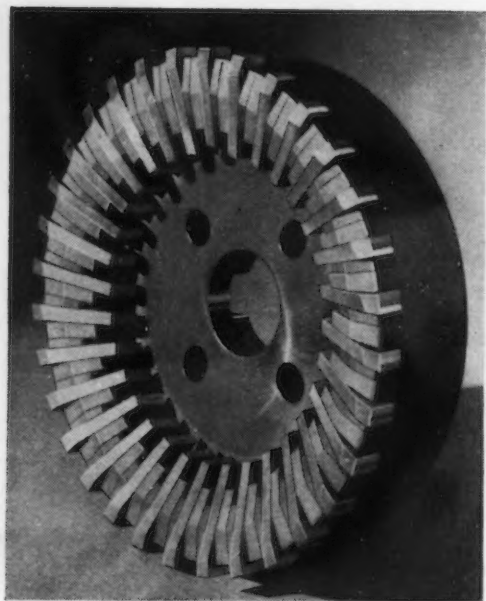
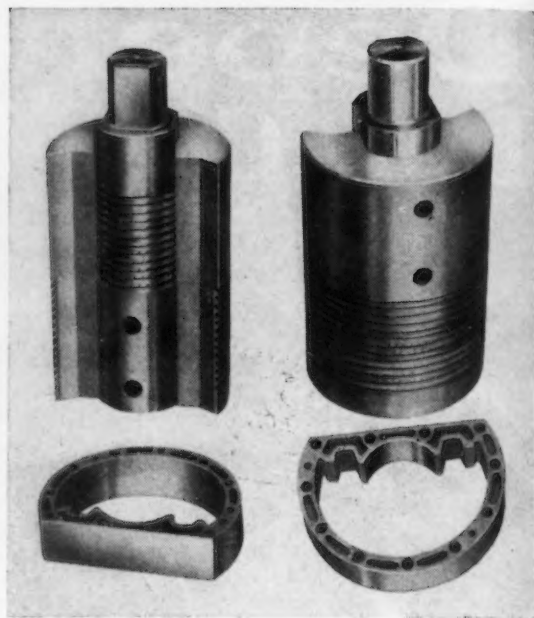


FIG. 13 AT LEFT  
INGERSOLL "Ray  
Blade" cutter.

o o o

FIG. 14 AT RIGHT  
AN Ex-Cell-O  
broach of un-  
usual shape.



and equipped with heavier blades where advisable. Improvements have also been made in blade adjustments and holding methods, which in some cases have resulted in entirely new designs. Many of the cutters now available are interchangeable with either high-speed steel or carbide-tipped blades, the latter becoming more in demand for many classes of work.

A recent development in inserted-blade milling cutters is one

developed by the Ingersoll Milling Machine Co., known as the "Ray Blade" cutter and shown in Fig. 13. A feature of this cutter is the method of mounting the blades. The blade itself is made with a double taper and is locked by a corresponding serrated wedge. The design is such that the blade cannot push down or back away from the thrust of the cut. This cutter is made in two distinct designs; one for roughing in which the blades

are adjustable radially, and another for finishing in which the blades are adjustable axially. The illustration shows the roughing type cutter.

#### Advances in Broaching

The art of broaching is no longer confined to the conventional small surface or internal operations that have been considered standard practice for so long. Likewise, broach construction is not limited to a single long piece of solid steel with integral teeth. They can be made up now of several sections to form either short or long units, to perform multiple operations simultaneously, for use in multiple sets depending upon the operation to be performed and, in fact, in many other different combinations.

The sectional broach has rapidly gained favor due to its economical performance. When mounted in a suitable holder the sections can be sharpened as one piece. When worn undersize a new section is added to the finishing end, moving all other sections forward, after which the entire broach is reground or re-sharpened.

Fig. 14 illustrates an unusually shaped broach made by the Ex-Cell-O Aircraft & Tool Corp. It was designed for broaching two opposed concentric arcs of different diameters. The part is a die cast frame. The larger diameter is 7 7/8 in. and the smaller 3 3/4 in. The broach is of the push type, the

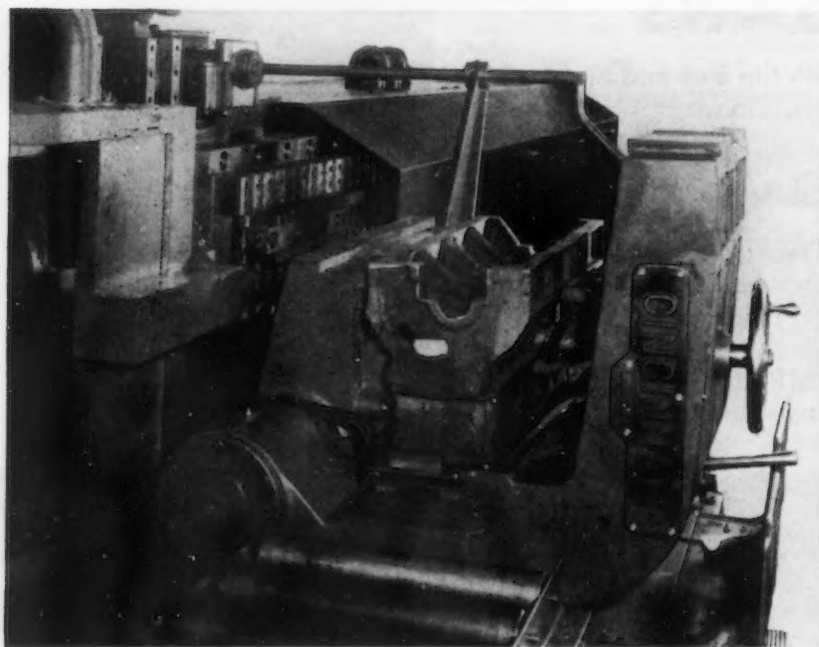


FIG. 15—Crankcase face finishing on a Cincinnati hydraulic broach.

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FIG. 16

### BROACHING cylinder head surfaces.

small diameter acting as a pilot while the large diameter is broaching, and the large diameter then acts as a pilot while the small diameter of the broach is taking its cut.

During the last year or so, the surface broaching of a wide variety of parts made of different materials has become quite common. This is true, especially in the automotive field, where such parts as cylinder blocks, cylinder heads and transmission cases can now be surface broached with complete satisfaction. At one time there was doubt as to the possibility of broaching irregularly shaped parts, such as outlined, because of the fear that the part itself would become distorted or perhaps break due to the strain of broaching. Early attempts had their limitations, but today this condition has been almost entirely overcome through the use of properly developed broaches and broaching ma-

chines which have reduced these hazards to a minimum.

A representative example of a modern surface broaching operation is shown in Fig. 15, and represents the set-up for finishing the crankcase face of an automotive cylinder block in a Cincinnati hydraulic broaching machine. The part is clamped in a rigid fixture which, as may be seen, is on the same plane as the roller conveyor, to facilitate loading. After the cylinder block has been clamped in place, the fixture is indexed 90 deg. so that the surface of the work to be finished is in line with the longitudinally-operated broach shown in the rear of the machine. The broaching operation includes the finishing of both sides of the crankcase face, as well as several bearing-cap surfaces, all of which are completed in one pass of the sectional-type broach. Firthite sintered carbide inserts are used for the finishing or final cut, as a result

of tests made to find the most effective type of material that would produce an accurate and smooth surface. Carbides have proved so far superior to tool steels for this purpose that they are used almost exclusively.

### Life and Speed of Broaches

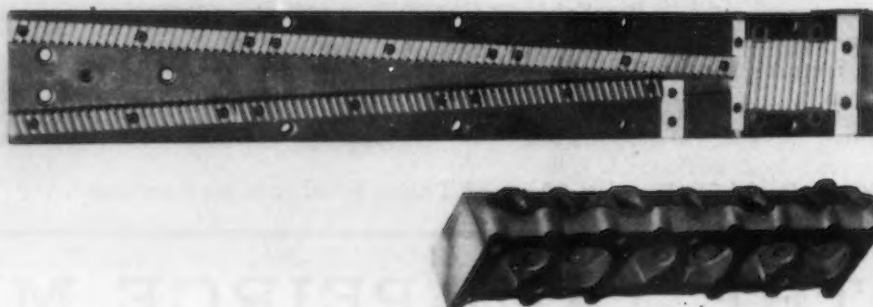
The broach operates at a surface speed of 34 ft. per min. and removes approximately  $3/16$  in. of material from all surfaces. The broach life is in the neighborhood of 2500 pieces per grind and the estimated total life is in excess of 250,000 pieces. The production obtained is from 50 to 55 pieces an hr. which is far more than that obtained by other means of surface finishing.

Cylinder head surfaces of blocks are also broached, the set-up being somewhat the same as shown in Fig. 16. The broach is made in three sections, each of which comprises a number of flat high-speed steel blades. The final blade used for finishing is a tungsten-carbide insert which is clamped in a separate holder. In this illustration the cylinder block is shown in the machining position after the broach has completed the cut. Broach life, rate of cutting and hourly output are comparable to the crankcase-face operation.

In broaching it is not always necessary to make a radical departure from standard practice, but there are times when the design of the broach may be changed in such a way that previous difficulties are eliminated.

On cast iron parts, where the outer scale must be removed as part of the machining operation, it is not always an easy matter to have the roughing section stand up

FIG. 17  
E X-CELL-O progressive type broach for roughing and finishing cast iron.





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as it should if each tooth is required to take the full width of cut. The actual breaking through of the scale is the most severe part of the cut and is often responsible for the short life of the entire broach.

width finishing section is provided, which takes the finish cut the entire width of the surface.

This design of broach requires a minimum amount of power to operate, and at the same time

serts which finish all surfaces in one pass from the rough casting, with the exception of the half bore which is bored to size after assembly of the bearing caps. The broach, an Ex-Cell-O product, is 78 in. long and approximately 4% in. wide. The oil-seal and bearing-lock surfaces are roughed by generating sections mounted on each side and finished by full-width inserts located toward the end of the broach. The round broach section for the half bore is made so that it can be rotated 180 deg. after one side has become dull in order to present a newly sharpened section. Any portions of the broach which became worn beyond use, or possibly damaged, can be replaced by new sections, thus restoring the broach to its original condition. This example clearly shows the rapid advancements that have been made in broach design.

#### Carbide Cutting Tools

Perhaps the most outstanding development in small tools during the past year is the much broader use of sintered carbides, both tungsten and tantalum grades, as ap-

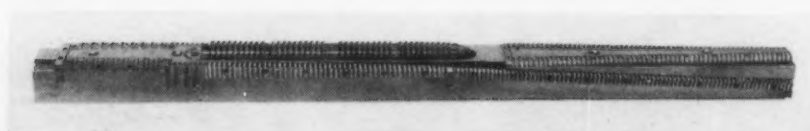


FIG. 18  
SECTIONAL broach for finishing half bores.



FIG. 19  
SINTERED carbide tool finishing oil-seal plate.

The broach illustrated in Fig. 17, developed by Ex-Cell-O, shows an effective method for overcoming this difficulty. It is of the insert type and takes a generating, or progressive cut. It finishes the end of cylinder heads in one pass. There are two rows of broach inserts arranged in the form of a V, with the open end of the V starting the cut. Instead of requiring the roughing teeth to shave the scale across the entire width of surface to be machined, each tooth throughout the length of the broach takes the full depth of cut, parting the scale in a transverse direction. By the angular arrangement of the inserts, a progressive cut is taken, machining the end of the cylinder head shown. At the point where the two rows of broach inserts join, a full

FIG. 20  
SHEAVE grooving with sintered carbide Firthite tool. Roughing.



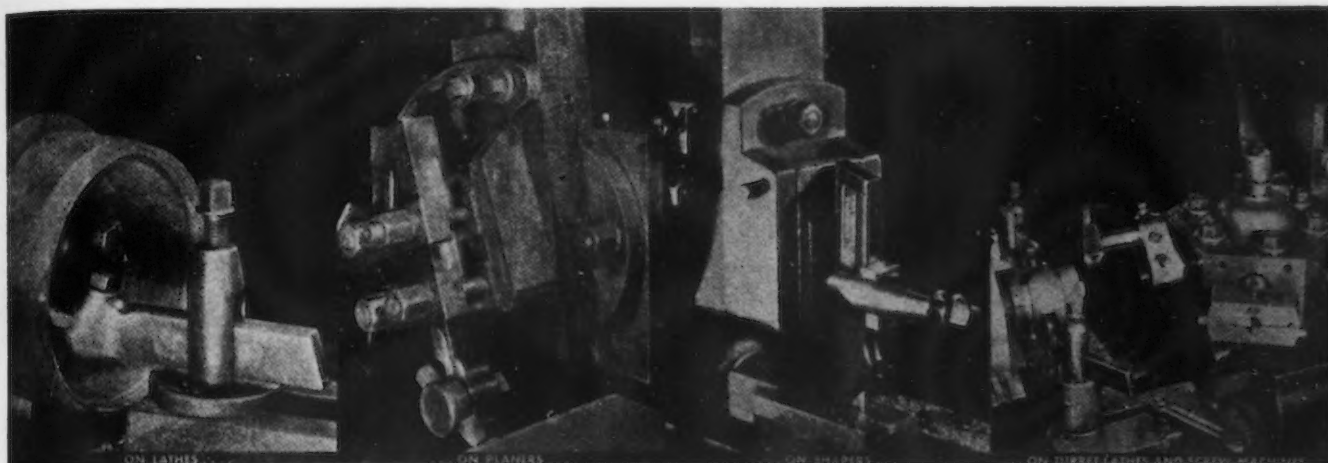
lengthens the life of the broach inserts.

An interesting example of a sectional broach for finishing the half bore, joint faces, bearing locks and oil seals of a cylinder block is shown in Fig. 18. It consists of generating, sizing and forming in-

plied to a wider range of metal-cutting operations. With increasing demands for larger outputs, carbide tools find a very prominent place, because they have the ability to remove metal faster than any other form of tool material. Likewise, the extreme hardness of car-

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### The Business End of Every Machine Tool is at its Cutting Point

PROFITS are made or lost at the cutting point of machine tools, for it is there that the work is done. The cutting tool as well as the man or his machine determines efficiency or inefficiency, accomplishment or delay, profit or waste, success or failure.

#### *Permanent, Multi-Purpose Tools*

The making of tools for standard operations is no longer a one-man task but has become the work of an institution which can coordinate the findings of cutting tool experts with the experience of thousands of shops. It is work for specialists who can specify steels; work out exact sizes and shapes; who command every modern facility for producing better tools.

ARMSTRONG TOOL HOLDERS used today in over 96% of the machine shops and tool rooms, "Save all Forging, 70% Grinding, and 90% High Speed Steel". They reduce "tooling-up" to the selection of the cutter, adjustment for clearance and tightening of the set screw. Each is a permanent, multi-purpose tool that with a few cutter bits (quickly ground from stock shapes of high speed steel) effectively equals a complete set of forged tools. With ARMSTRONG TOOL HOLDERS you are permanently tooling-up, are always ready to start work. Large stocks of costly cutting steels are no longer necessary nor must you absorb direct loss in useless tool "stumps".

#### *Stronger, More Efficient Tools*

You will find in each ARMSTRONG TOOL HOLDER maximum strength and rigidity, maximum utility not only for the operation of today but for tomorrow's job as well. Cutting angles and tool range will be correct—worked out and proven.



Comprising over 100 sizes and shapes, the Armstrong System of Tool Holders provides for every operation on Lathes, Planers, Slotters and Shapers and for standard operations on Turret Lathes and Screw Machines. The new ARMSTRONG TURRET LATHE and SCREW MACHINE TOOLS embody the same basic principle as other ARMSTRONG TOOL HOLDERS and are manufactured and sold as standard tools.

While ARMSTRONG TOOL HOLDERS take cutter bits of standard high speed steel shapes—cutters that can be bought anywhere, at any time—one of the developments of the Armstrong System is ARMSTRONG HIGH SPEED Bits and Blades. ARMSTRONG HIGH SPEED Steel Bits and Blades are individually heat treated and tempered; are accurate in size and surface. Each is strictly speaking a fine tool in the rough that is capable of operation at greatly increased speeds and feeds and open a new avenue for increasing hourly production. So slight is the cost of the cutting steel compared with the man and machine hours it governs, there can be only one truly economical cutting steel—the very finest obtainable—ARMSTRONG HIGH SPEED.

ARMSTRONG TOOL HOLDERS are as available as your nearest Mill Supply House—can be purchased as needed, when needed. Adding but a tool at a time, it is possible to build your Armstrong System of Tool Holders without special investment, without interruption, without even disturbing any tool set-up you may now employ.

Lower tool costs, lower cutting-costs and step up production and profits by standardizing on ARMSTRONG TOOL HOLDERS for lathes, planers, shapers, turret lathes and screw machines.



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"The Tool Holder People"

New York Sales Office: 199 Lafayette St.

Pacific Coast Office: 661 Folsom St., San Francisco, Cal.

London Branch: ARMSTRONG BROS. TOOL CO., Ltd.

bides insures longer tool life and a finer type of finish, usually with improved accuracy. These gains are attractive because they not only offer worth while machining economies, but are also the means of making a better and more uniform product.

New grades have been developed for additional purposes, other grades have been improved to offer better performance. Carbide-

tool design has advanced rapidly and generally speaking, results are far more efficient because of better application methods. More is known about the requirements to insure maximum performance, and users have endeavored to make such corrections as might be needed to improve results. All these factors have contributed to the use of carbides for new applications, which undoubtedly will have a far

reaching effect during the coming year.

Since an unusually smooth and accurate finish can be obtained when machining materials at higher speeds, sintered carbide tools are preferred for various applications aside from their higher producing qualities. An example of this kind is the finishing operation of the cast iron oil-seal plate shown in Fig. 19. The surface of this plate must be exceptionally true and smooth in order to produce an oil-tight surface. This type of cut is accomplished by the Firthite tools shown, which rough and finish the face at speeds of 200 and 250 ft. respectively.

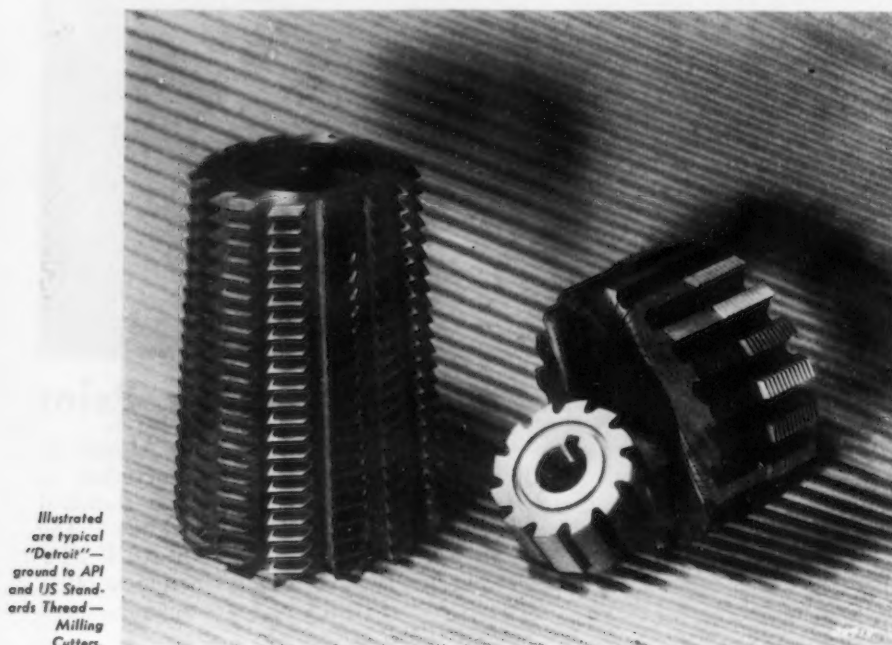
Other operations handled at the same time include the boring, counterboring and partial turning of the diameter. Contrasted with high-speed steel performance, carbide tools give three times the life in addition to 30 per cent more output. Many parts such as this, which formerly required scraping or perhaps grinding as a means of finishing, can now be finished satisfactorily by carbide tools, within close limits, thus eliminating additional operations.

#### Turning and Grooving Sheaves

An application for carbide tools used quite broadly is the turning and grooving of sheaves. In Fig. 20 is shown a set-up for turning a 14-in. diameter sheave with a Firthite tool in a turret lathe. The material is semi-steel and somewhat hard in nature. With high-speed steel tools machining was done at a speed of 50 ft. per min. With a Firthite tool, the diameter is now machined at 150 ft. per min., which offers a substantial reduction in machining time and clearly shows the advantage of carbide for such cuts.

The setup for finishing the grooves is illustrated in Fig. 21. The cutting speed used with carbide is approximately 125 ft. per min., as compared with a high-speed steel speed of 40 ft. per min.

A multiple carbide tool setup for turning, facing and grooving small cast iron fan pulleys is shown in Fig. 22. This operation is handled in a two-spindle Potter & Johnston automatic, using various types of special tool blocks. Except for the drills and tap chasers, all tools in this setup are Firthite tipped. The cuts include rough and finish bor-



Illustrated are typical "Detroit"—ground to API and US Standards Thread—Milling Cutters.

**TAPS**—Ground Form threads checked with the finest Zeiss Equipment.

**GAGES** (thread)—Produced under controlled temperature and humidity. Burnished wear-resisting surface.

**DIES** (button and thread rolling)—Lower threading costs with DETRO steel dies.

**CUTTERS** (thread milling and worm hobbing)—Ground to the most rigid API or US Standards.

**SERVICE**—24-hour production to insure the most rapid delivery possible on special taps, etc.

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**DETROIT TAP & TOOL COMPANY**

8432 Butler Street

Madison 9898

Detroit, Michigan

ing, turning of the O.D. and hub, facing of the hub and pulley rim, and the V-grooves. The floor-to-floor time for operation is 4¼ min. a pair, which is equal to 22 to 24 pieces an hr. after making allowance for lost time.

Sintered carbide tools are used to advantage for boring operations of different kinds where the limits of accuracy are somewhat exacting. Such an example is the machining of cast iron motor frames shown in Fig. 23, also handled in a P & J automatic. The part is held by a special pot fixture and is located from the previously finished feet, receiving adequate support around the outer circumference to avoid vibration or deflection. The operation includes the rough and finish boring of the 11½-in. diameter hole, as well as facing and cutting of the rabbet fits on both ends. A frame is completely finished in a floor-to-floor time of 12 min.

#### Increased Output Obtained

On operations such as this, tool performance is of utmost importance because accuracy is very essential. Recently in finishing boring a similar frame, somewhat larger in diameter, also longer, difficulty was experienced with high-speed steel tools, inasmuch as excessive wear resulted in tapered holes. Moreover, these tools often broke down in the middle of the cut and the difficulty of starting new tools under such conditions is obvious. On the average only two to three frames per grind could be obtained. The application of carbide on this job overcame the difficulties, because tool life was increased to 40 to 45 pieces per grind, with a much better degree of accuracy. This example is cited because the savings are remarkable, especially in view of the fact that output was increased approximately 25 per cent.

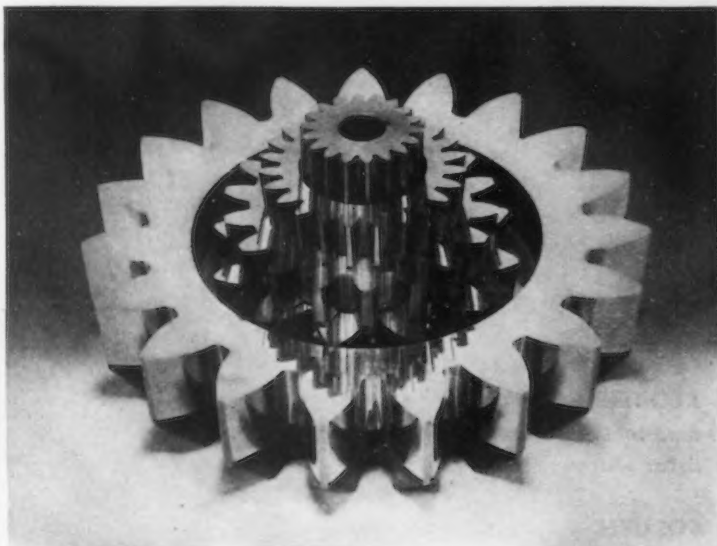
Another example showing the advantages of carbide tools is shown in Fig. 24, which represents a setup for finish boring of automotive brake drums. The material is a cast alloy, exceptionally hard and abrasive in nature, so that ordinary high-speed tools are not likely to stand up satisfactorily. With a Firthite tool, however, due to the extreme hardness of the cutting edge which is less affected by adverse conditions, it is possible to

obtain much better tool life, as well as to permit machining at much higher speeds. On this cut, approximately 1/32 in. of material is removed at a speed of 350 ft. per min., and an exceptionally accurate and smooth bore is easily obtained.

Output is not always the outstanding gain in using sintered carbide tools. In Fig. 25 is shown a typical installation that exemplifies another form of economy. The

operation is the form turning of a cast brass plumbing fixture. The part is 10 in. long and is machined with a Firthite-tipped skiving tool at a speed of 320 r.p.m. using a feed of 2½ in. per min. The average depth of cut is 1/32 in. Because of the better finish, free from tool marks, made possible by this carbide tool, there has been a reduction in subsequent grinding and polishing costs from 8½c. to 3¼c.

*Picking the right tools is a science. Making really good tools like these shaper cutters and master gear is an art. Asking for MITCO tools is just horse sense.*



## LITTLE-KNOWN FACTS ABOUT MITCO TOOLS:

*Michigan Tool Company is the only major manufacturer offering a complete line of cutting tools—standard and special . . . It is the only tool company offering a complete line of hard metal tools—high speed, tungsten carbide, and the intermediate "CROBALT".*

**Write for complete information on engineering and tooling services.**

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per piece. The tool, after completing 50,000 pieces, has saved the user more than \$2,600. A slight increase in output, because of fewer tool changes, is obtained, but the outstanding gain, nevertheless, is the substantial indirect savings made possible by producing a better finish.

An unusual type of carbide tool installation is shown in Fig. 26, which represents the machining of

an alloy cast iron cylinder sleeve for a diesel engine. The setup, handled in a Jones & Lamson Fay automatic, shows the advantages of a multiple-tool setup, inasmuch as 16 Firthite-tipped tools are used to turn, groove, face, chamfer and under-cut various surfaces at one setting, thus insuring concentricity and better accuracy. Only both ends of the sleeve are machined as shown. The material is of a hard

nature, which is one of the requirements of diesel-engine cylinders. This condition alone causes some difficulty in connection with the use of ordinary cutting materials, but has far less effect on carbides.

The boring of diesel cylinders is, quite naturally, another application suited to sintered-carbide tools. In some cases it has been possible to increase the hardness of the material used for cylinders to about 50 Rockwell C, so that it is still machineable with carbides. Usually two cuts are taken, one roughing and one finishing, which in combination produce a smooth accurate core. Machining of harder materials requires the use of much slower speeds and usually more rigid setups.

#### Correct Size and Design Important

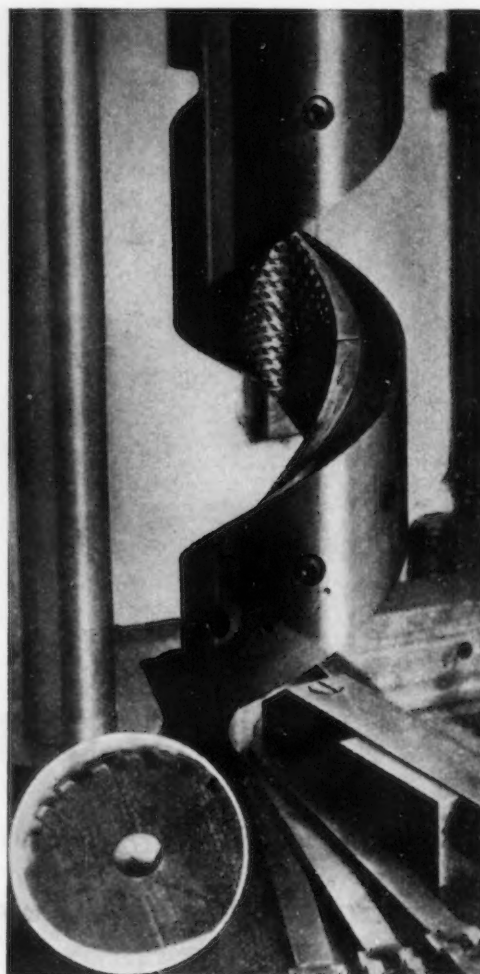
A combination Firthite and high-speed steel setup for turning and facing cast iron printing press rolls is shown in Fig. 27. The operation, also performed in a J & L automatic, is that of finishing the roll after assembly with the shaft. The roll is rough turned in a similar manner, in a preceding operation, using multiple carbide-tipped tools. The procedure carried out is to chuck the part and first turn one end with four tools. After a quantity of rolls has been completed, they are rerun for the roughing of the opposite end. It is obvious that the cut is of an intermittent nature since approximately 173 of the periphery is cored out. This type of cut has little effect on carbide tools provided they are of correct size and design, and properly supported.

After the shaft is assembled, a finish cut is taken on the diameter and face by five carbide tools, at the same time that the shaft end is finished turned with tool steel tools. The wide difference in diameters made an interesting setup, because Firthite tools finish the cast-iron roll at a speed of 250 ft. per min., whereas high-speed steel tools, used for the steel shaft, operate at approximately 80 ft. per min. which is somewhat of a correct speed relation for both types of cutting materials.

An example of face milling with tungsten-carbide cutters is shown in Fig. 28, the part being a malleable iron differential cap which is finished by means of a continuous-type rotary fixture. This operation

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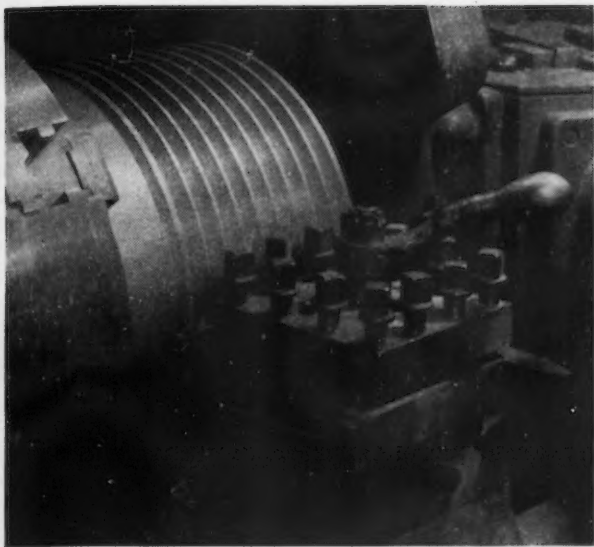


FIG. 21—Sheave grooving showing groove finishing with Firthite tool.

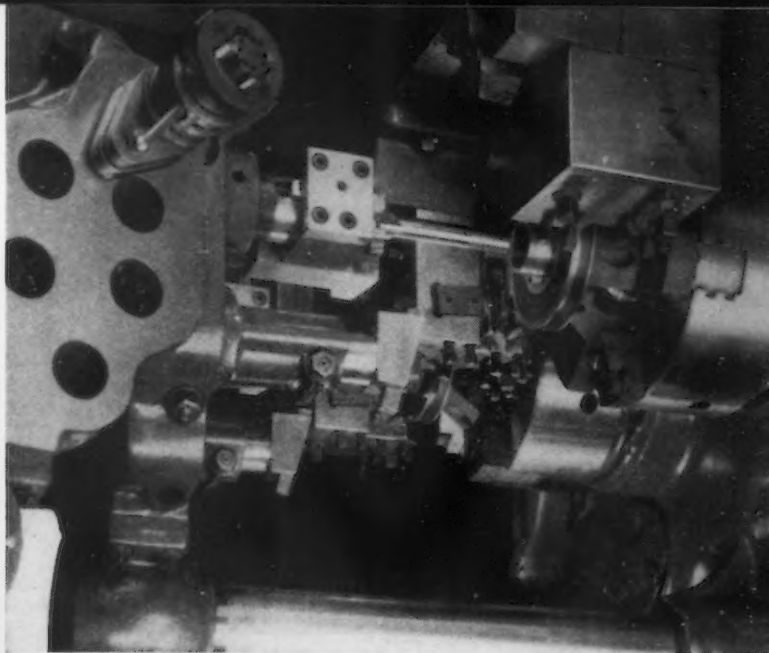


FIG. 22—A multiple carbide tool setup.

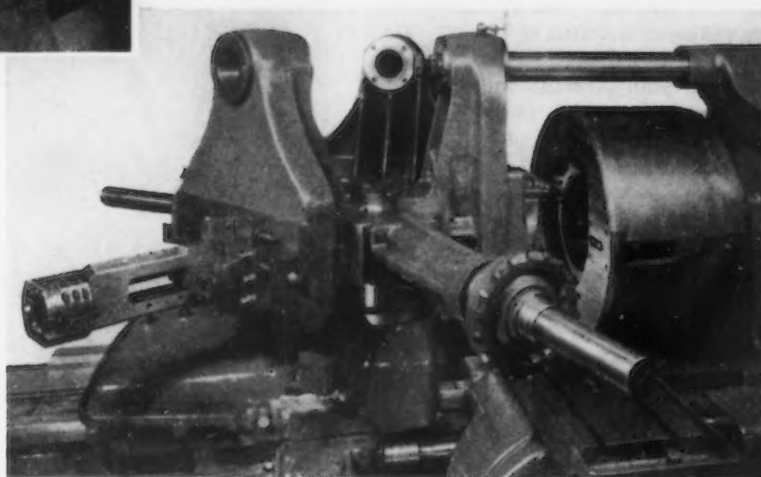


FIG. 23—Boring with sintered-carbide tools.

is of unusual interest because of a slight error made in the design of the part. The layout did not allow a sufficient amount of material for machining, which, on a part of this kind, would be approximately  $\frac{1}{8}$  in. Several thousand castings were made with only  $\frac{1}{32}$  to  $\frac{1}{16}$  in. stock for finishing. Because of the nature of the material, ordinary tool steel blades did not hold up satisfactorily, and on the average only 200 to 300 pieces between grinds were obtained. After changing to carbide-tipped blades, the effect of the scale was not at all detrimental to the cutting edges, with the result that the cutting speed was increased to approximately 300 ft. per minute, using a feed of 15 in. per minute and which in turn has resulted in a cutter life of over 20,000-pieces between grinds. In many face-milling operations of this kind, using



FIG. 24—Finish boring brake drums with sintered-carbide tool.

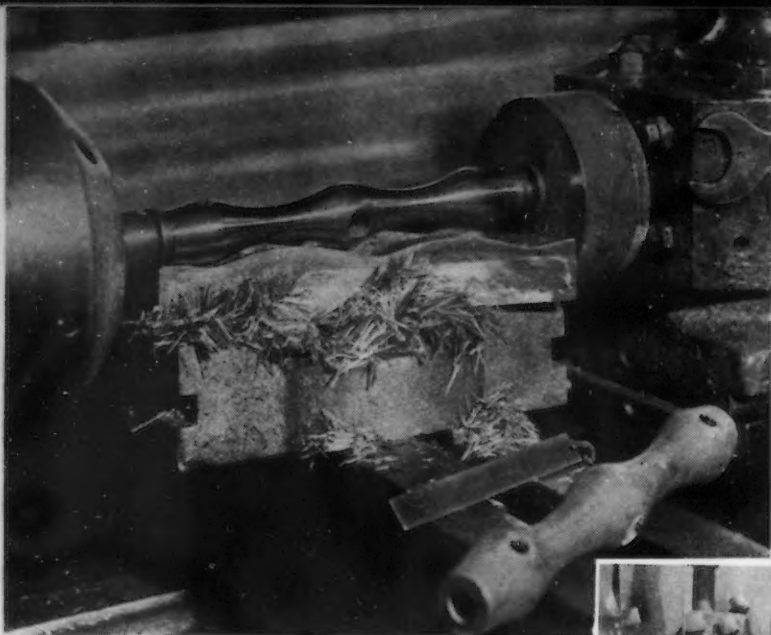


FIG. 25 AT LEFT

THIS tool saved its user \$2,600 on brass forming.

substantial reduction in subsequent operations; a reduction in depth of cut usually allowed for finishing purposes; and the possibility of machining the harder or tougher materials that have advantages in certain types of products.

#### Gages

Gages have a direct relation to small tools because their basic use

carbide blades, it has been possible to reduce the depth of cut on surfaces to be finished so that a substantial gain is made through the saving of material ordinarily removed in the form of chips.

Another gain very often made possible with tungsten-carbide milling cutters is the combining of roughing and finishing cuts into one. This is possible largely on account of the high speed at which surfaces are finished, which in itself reduces the generation of heat to the part and lessens the chance of distortion. An example of this kind is shown in Fig. 29, which represents the milling of three joint surfaces on cast iron filter bodies in a Milwaukee Simplex milling machine. The material is of a medium-hard nature and requires the removal of approximately  $\frac{1}{8}$  in. of material. The cutter is 6 in. in diameter and is operated at 252 ft. per min., with a 17 in. per min. feed. The surfaces are machined exceptionally smooth and flat in one cut, as compared to two cuts with former cutters. The fixture used is of the progressive type, that is the parts are transferred from one station to another so that with each cycle a complete filter body is finished.

The foregoing illustrations offer a summary of the various economies made possible through the use of carbide-tipped tools. They include: An increase in output as a result of faster cutting speeds and feeds; longer tool life even under adverse conditions; a better, smoother finish with less chance of distortion; the possibility of combining roughing and finishing cuts into one; the elimination or a

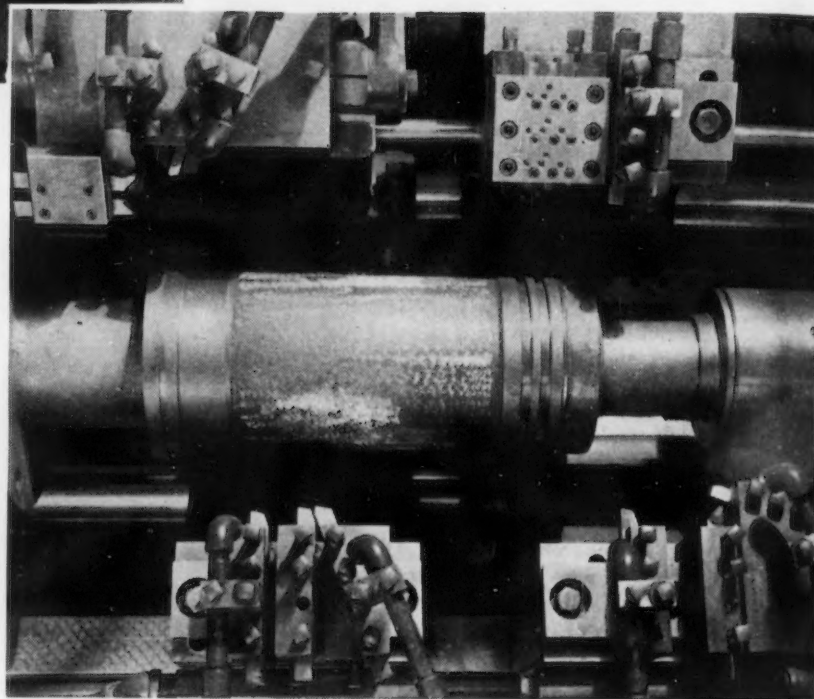


FIG. 26—Unusual carbide tool installation at work on diesel sleeve.

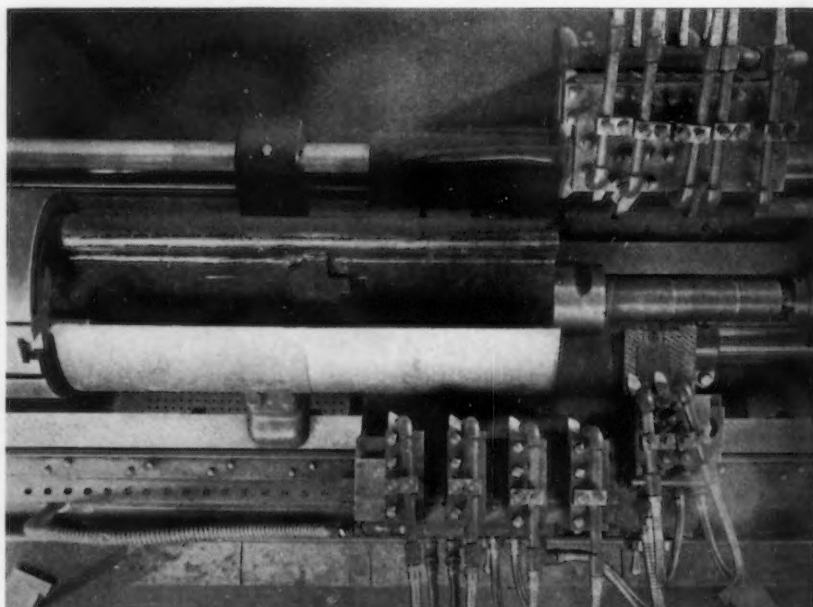


FIG. 27—Combination Firthite and high speed setup on printing roll.

is to inspect the accuracy of machining operations. Reference to gages, therefore, is synonymous with small tools.

As in the case of cutting tools many developments have been made in gages, principally to insure better inspection and to aid in the interchangeability of mechanical units.

In general, gage improvements have been more toward a permanent accuracy, such as through the use of better materials, stronger and more solid designs where ad-

FIG. 28—AT RIGHT

FACE milling with tungsten-carbide cutter.

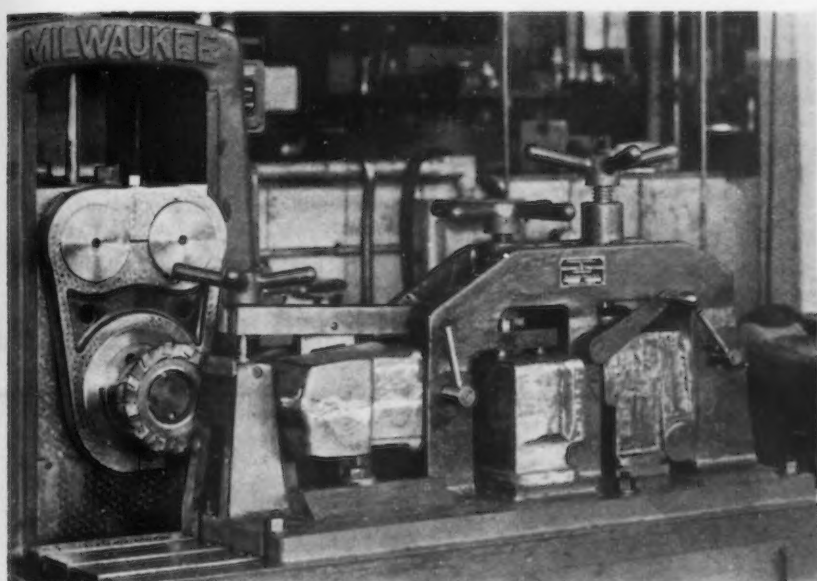
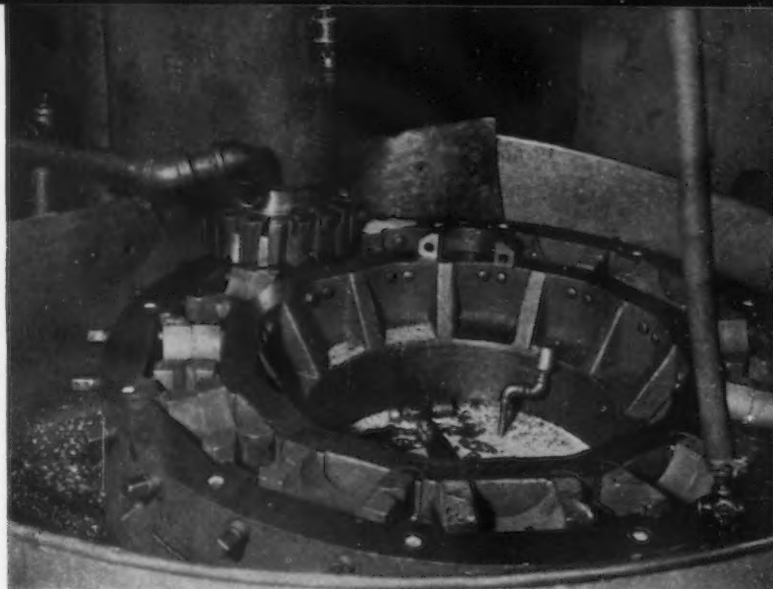


FIG. 29—Combining roughing and finishing cuts with carbide cutter.

visable, a higher degree of finish to the gaging portions, longer wear and in some cases new principles or designs, especially in connection with automatic inspection methods. Special gages, too, have found prominent uses and constitute a wide field of application.

Shop executives, today, consider inspection with a great deal more importance, because experience has shown that it is largely a means of controlling the value of a product and an important factor in reducing losses that might result through improper workmanship.

With limited space, reference will be confined to a few gages made with sintered or cemented-carbide inserts, more to point out their possibilities.

#### Inserts on Snap Gages

Snap gages of American Gage Standards are excellent applications for carbide inserts, especially where severe wear is experienced. Carbide-tipped plug gages, also, offer remarkable performance. On one application, requiring the 100 per cent inspection of  $\frac{1}{2}$ -inch holes on 14,000 parts daily, the life of a Firthite plug gage was more than 10 times that of other designs, which included steels of various kinds, having different treatments and even chrome plated.

In Fig. 31 is illustrated a P & W Electrolimit gage used for checking size, roundness, straightness and local imperfections of holes. The contact of two carbide inserts in combination with a diamond gaging point, working through electrical connections, registers the



FIG. 31—Electrolimit gage made by Pratt & Whitney Co.

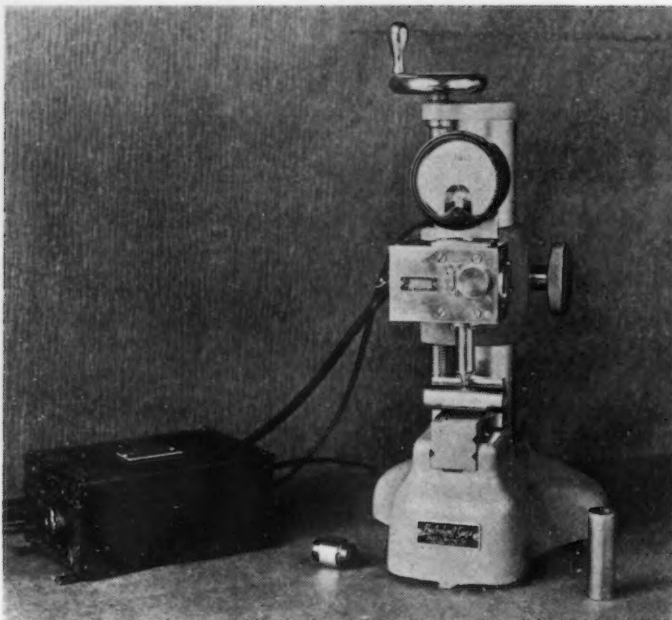


FIG. 32—Electrolimit gage measuring outside dimensions.

size of the bore on a direct-reading ammeter or indicating instrument. This type of gage is suited to a

wide variety of work, while the principle lends itself to use for outside dimensions as shown in

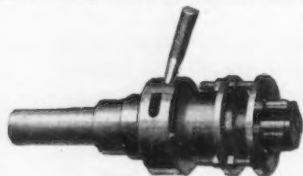
Fig. 32. The part is a wrist pin which rests on an anvil having a carbide insert. The stop plate is also carbide-tipped.

The exacting tolerances of refrigerator parts have caused tool engineers to become gage-minded and the two types that follow are quite representative, both having been built by the R & M Mfg. Co., Detroit. In Fig. 33 is illustrated a gaging fixture for checking the squareness of the face with the bore in the part shown in place. This part rests on three tungsten-carbide inserts. A small lever fulcrumed and located in the pilot or plug member, and having a 3 to 1 ratio, contacts an indicator graduated to 0.0001 in. This combination permits readings to be made whereby each graduation registers out of squareness by 33 millionths of an inch. This gage has proved so sensitive that the master ring used for setting had to be made with exceptional precision.

Another squareness testing fixture is illustrated in Fig. 34. The

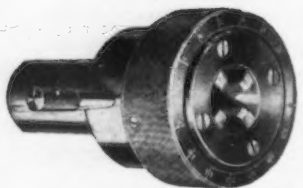
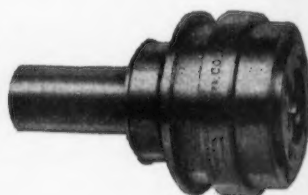
## It's in the DESIGN

Pace-setting equipment, tops in quality! The complete Line of Murchey Collapsible Taps and Self-Opening Die Heads is designed for fast and accurate threading—with an eye to the greatest possible economy obtainable. That's why Murchey Tools are popular.



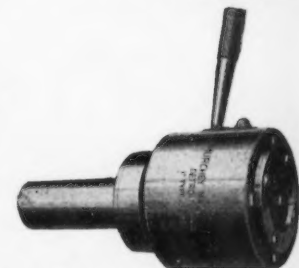
**Type "C" Collapsible Taps**—Rotating and Non-Rotating by removing the handle. Changeable chasers without removing cap. Positive collapse.

**Type "CO" — Rotating Self-Opening Die Heads.** For live spindles. Opened and closed by collar trip. Chasers backed up with solid bearings.



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FIG. 33—Fixture for checking face squareness with bore.

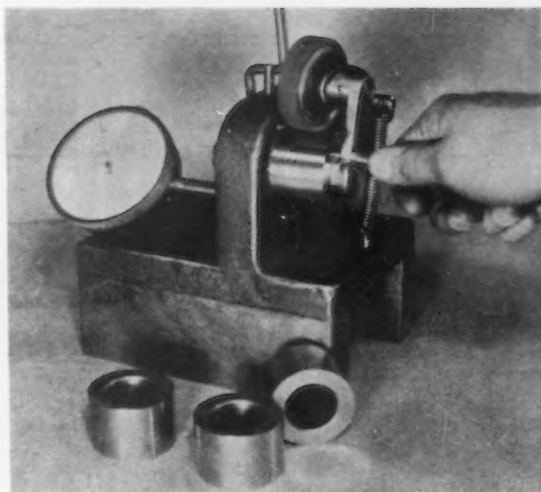


FIG. 34—Another squareness testing fixture and gage.

part, as shown at the front, is placed over a stud, provided with two carbide inserts, positioned 90 deg. apart. A rubber-treaded wheel, which contacts the outside surface of the work, is set at an angle with the axis of the part so

that when it is turned it exerts a slight pressure on the work, causing it to bear against a single stop at the top. The indicator reading is taken directly opposite at the bottom. This inspection is quite rapid and indicates double error

of any out-of-squareness, since the part is held down on the carbide inserts and tight against the stop that it is set 180 deg. from the indicator point. Any errors to 0.0001 in. can be taken with this inspection fixture.

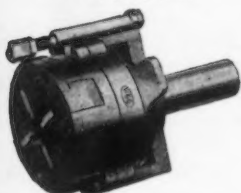
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for rotary spindles.



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for hand turret machines.

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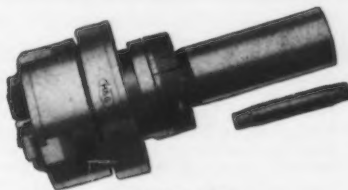
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**STYLE IMM**  
is equipped with improved internal trip for shoulder threading such as for spark plugs.



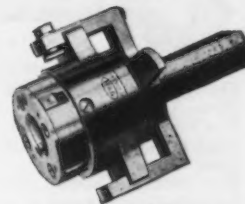
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has receding chasers for cutting superior quality taper pipe threads.



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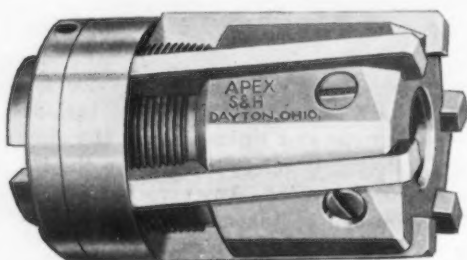
...of cost-cutting **production tools** is well *balanced, highly efficient and greatly enlarged*

The Apex Line is a collection of highly efficient production tools for drilling, tapping, boring, reaming, stud and nut setting, and screw driving.

Now the scope of the Apex Line is increased by the complete line of reamers formerly manufactured by the Schellenbach-Hunt Tool Company, of Cincinnati, Ohio.

Established in 1899, this old line plant has long been known for its quality products.

Now Apex offers these tools—with the added O.K. of Apex experts as part of an efficient, well balanced line of production tools. Write for Catalog No. 8 and complete information about The Apex Line.



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The blades for the shell and machine reamers are the same for the corresponding sizes and will interchange with "X-L" Machine Reamers. The shell reamers are regularly furnished with straight holes but taper holes can be furnished when wanted.



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Stronger—size for size—than any others on the market. No projecting ears, pins, screws, sharp corners. Cannot over travel their maximum working angle. 12 diameters— $\frac{1}{2}$ " to 4".



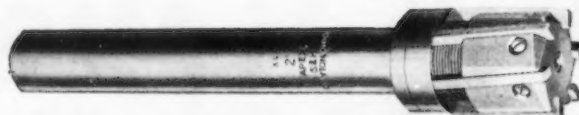
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Drive taps to capacity on through or bottom holes—patented safety friction practically eliminates breakage. Set studs and nuts to pre-determined uniform tension.



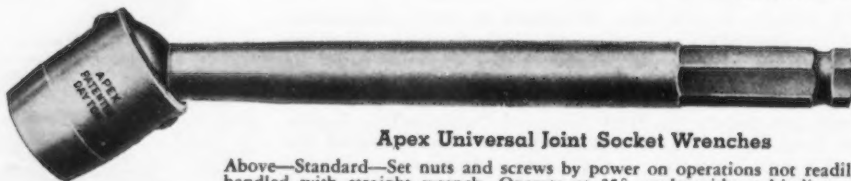
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Below—Tension Type—Tension sleeve holds socket in alignment with shank—allowing working angle of 35°. Easy to locate and set nuts and screws in difficult places.



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Morse Taper Collets  
Free Floating Tap Collets  
Straight Shank Drill Collets  
Close Center Chucks  
Positive Drive Chucks  
Vertical Float Tapping Chucks  
(Positive and Friction Drive)

Safety Friction Tapping Chucks  
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Semi Floating Tool Holders  
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# FORMING AND FORGING

*Marked improvement in equipment, increased production rate and increased precision of product characterize the year's developments in forging.*

By F. L. PRENTISS

*Cleveland Editor, The Iron Age*

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DEMANDS upon the forging industry and uses for forgings expanded with the revival of the metal-working industry during 1936, and the volume of commercial forgings increased about 25 per cent over the previous year. Equipment builders looking for ways to improve the quality of their product, increase strength and reduce weight without sacrificing strength turned to forgings for certain parts requiring uniformity and physical properties.

Forgers met the demand of users for forgings of closer tolerances, lighter weight and requiring the minimum of machining. Speed of production of forgings has in-

creased and forging practice and the quality of forgings have continued to improve. More intricate forgings are being made than ever before. Considerable credit for this is attributed to the efficient work of forge shop engineering departments. Increased interest in forgings is being shown by prospective users, this being stimulated by the group activities of commercial forgers through the Drop Forging Association.

The trend in the manufacture of forging machines and hammers has been towards the construction of more accurate machines, heavier hammers and faster production. Builders of both hammers and upsetters have kept pace with the demands of forge shops by designing machines to meet new requirements.

Builders of forging machines did a very good volume of business last year. While forge shops in the

automotive field purchased a great deal of equipment, forging plants in other industries, as well as jobbing forging shops, lagged behind as in previous years in replacing old and obsolete equipment with new machines.

Draft angles were further reduced last year to  $1\frac{1}{2}$  deg. in the forging of crankshafts. Weight tolerances are being held to closer dimensions on connecting rods. A connecting rod weighing less than 2 lb. used on one automobile is held to less than  $\frac{3}{4}$ -oz. weight tolerance by a Cleveland forge shop. The same forger is making a 175-lb. connecting rod for a diesel engine with a weight tolerance of 8 oz.

Press forging is on the increase. The manufacturer of a low price automobile recently substituted press forgings forged from preformed blanks for the manufacture of support arms for front action

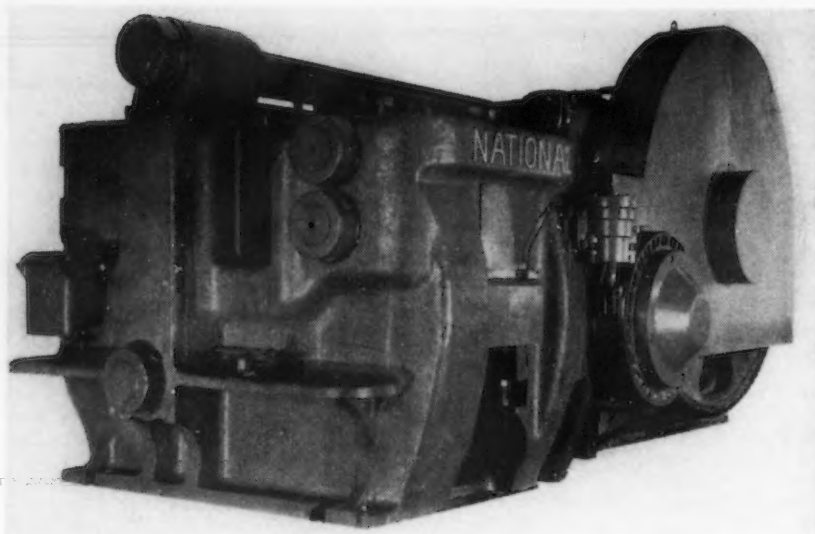


FIG. 1—ABOVE

A MODERN, high-duty forging machine must combine massive strength and rigidity.

spring mechanism, which heretofore were drop forgings. While a press is not able to displace stock like a hammer, the making of a forging by the press method, if a preformed blank is used with metal distributed properly, is regarded as very economical. In making this arm there are two operations that are performed on a press, first forging, then coining.

### Coining

Coin pressing of forgings is becoming a more common practice in industries in the making of forgings for parts for equipment for which higher stresses and better steel are demanded. What formerly was regarded as good enough for almost any part not requiring extremely close tolerances is now passé. Many forgers now regard coining as good practice in making parts for which a tolerance of 0.001 in. is sufficient and are able to save costs by eliminating machine work. Manufacturers who are resorting more generally to

coin pressing include makers of agricultural machinery, tractors, and particularly road building machinery.

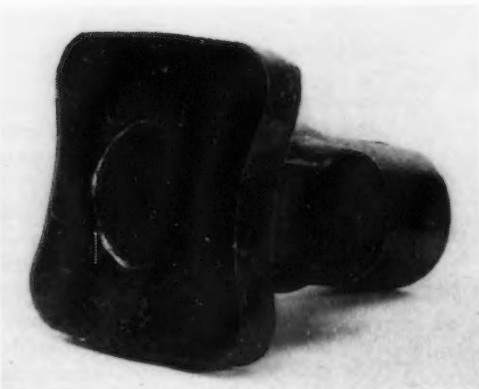
While most coin pressing is done cold, the hot coining method is followed when a better flow of metal is wanted to obtain a smooth finish or when the elimination of strains that are set up by cold working is desirable. Parts also frequently are being coined hot when their areas are too high for normal cold coining. Some forgers are hot coining with the drawing heat of heat treatment or under the scaling temperature of 1200 deg. F.

Use of forgings in oil refineries is increasing, particularly for parts capable of resisting high temperature and high pressures. More stainless steel forgings are being used in the oil and chemical industries. As close temperature control is important in making stainless steel forgings, use of furnaces with pyrometric control is regarded as important.

The manufacture of 3-in. and 6-in. shells by the displacement instead of the extrusion method is a recent development that still is in the experimental stage. Reduction in the manufacturing costs is an advantage claimed for the displacement method.

A trend is reported in the more general use of upsetters for making forgings requiring long holes which can be pierced, thus eliminating drilling and for making transmission and cluster gears.

There is a growing tendency among forgers to use controlled atmosphere furnaces, providing a reducing, non-oxidizing atmosphere for both the forging furnaces and for heat treating forgings. In



FIGS. 2, 3, 4

TYPICAL examples of modern, low weight, minimum finish, internal displacement forgings. Nearly all of the material from the holes is displaced outwardly during the forging operations.

o o o

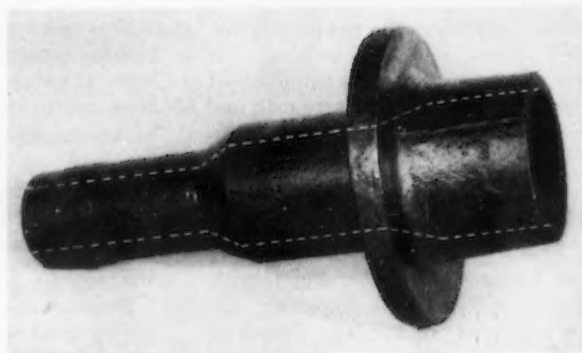




FIG. 5

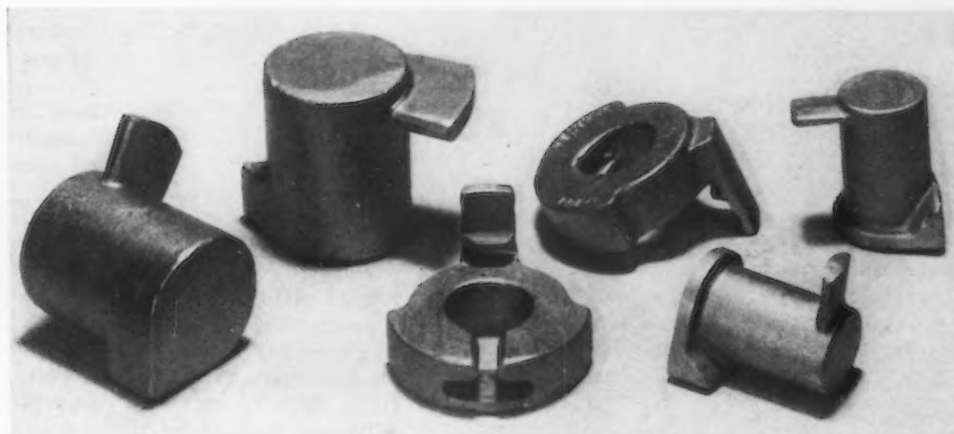
THIS forging was both punched and trimmed in the forging press. It required accurate tool and die registration to insure accuracy and to avoid tool interference and breakage.

side are now being made of forgings by the Champion Machine & Forging Co., Cleveland. These cylinders are subjected to severe pressure from the oil or air inside the cylinders when a plane lands, making it necessary to have cylinders with walls with fine, dense grain heat treated to strengths that will withstand stress and shock. Forgings are also used in making many airplane parts which were formerly built up sections.

Another use of forgings that is becoming more common is for dipper racks for steam shovels. Most

FIG. 6—AT RIGHT

ODD and intricate forgings produced by the Rockford Drop Forge Co. by forging and coining. These parts, it is stated, could not be economically produced by machining methods.



the forging furnaces the atmosphere is controlled by the automatic temperature control valves.

In heat treatment the Tocco process for hardening crankshaft bearings was the outstanding development during the year. Localized hardening of crankshafts at the bearing surface is accomplished by hardening by the induction process. A high frequency current at high voltage is transformed into low voltage with high amperage and this current passes into inductor blocks which surround but do not actually touch the bearing area that is to be hardened.

Under the process the necessity of heat treating the entire shaft is avoided, resulting, it is claimed, in a decided saving in costs.

#### Airplane Parts

Airplanes are using more forgings to give assurance that certain parts have the required density and grain flow and hence adequate strength. Cylinders for shock absorbers on airplane struts having a wall thickness in many cases of only  $\frac{1}{8}$  in. after machining the in-

FIG. 7

THE vertical Maxi-pres is a comparatively recent development for coining parts after forging.

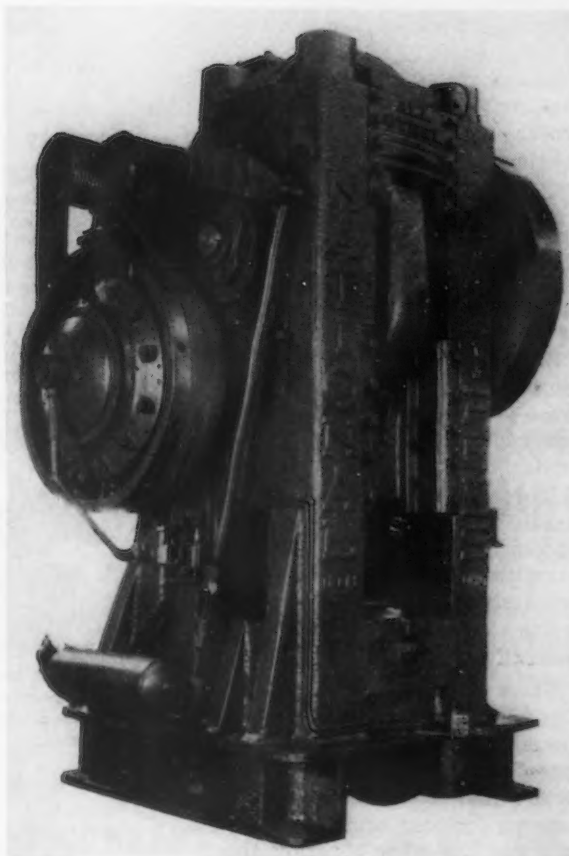




FIG. 8

**A** GROUP of non-ferrous forgings accurately finished on a Maxipres.

of these are made of carbon manganese steel heat treated. A maker of overhead conveying equipment has adopted forgings for parts subjected to strain and constant wear.

Tractor manufacturers are increasing the number of parts that are made of forgings and assembled by welding, adopting forgings for such parts as are forgeable, particularly to assure uniform physical properties. For track shoes for one model of tractor the Cleveland Tractor Co. is now using forgings weighing 40 lb. each, the two tracks taking one ton of these forgings.

#### Standard Tolerances

Standardized tolerances for forgings covering drop, hammer and upsetter forgings are being prepared by the Drop Forging Association. Forging manufacturers feel the need of standard tolerances because of the demands of many customers for forgings with very close limits. The proposed standards are to cover thickness, width, and/or length, shrinkage, die wear, mismatching, trimming to size and quantities. The purpose of the proposed standards will be to standardize extras that are now rather generally applied.

Under the proposed plan forgings will be placed in three groups, special, requiring very close tolerances, and regular which is subdivided into two classifications, one covering ordinary commercial forgings and the other covering those

calling for one-half the tolerances of ordinary commercial forgings.

The arrangement of forge shops for continuous production, thus materially reducing handling costs, is stressed as an important advance in the drop forge industry by the Transue & Williams Steel Forging Corp., Alliance, Ohio.

"With the pronounced increase in forging business during the past year and the well justified expect-

tancy of a banner year in 1937, the drop forging industry has emulated the ideas of the steel mills in arranging equipment for continuous production," says R. W. Thompson, sales engineer of that company.

"In order to effect increased economies and reduce handling costs on production items, the drop forger has established forging units whereby the successive operations of forging are arranged in continuous sequence and the forging completed without the necessity of expensive reheating, handling and transportation from one department to another. Such units are now commonly employed in the forging of connecting rods, axles and crankshafts, and comprise one or more hammers with such auxiliary equipment as upsetters, straightening presses, forging rolls and even heat-treating furnaces.

"These units in the past were to some degree thought impractical due to the fact that a breakdown in any piece of equipment caused a tie-up of the whole unit, thereby increasing the lost time by the number of production centers in the unit.

"The new designs of forging equipment with improved construction embodying increased rigidity and strength provide longer continuous operation which is nec-

FIG. 9

**A** PRESSURE finished connecting rod, which was trimmed, then normalized, the pressure finishing being done on the normalizing heat. Note the slight amount of flash. This is an example of Maxipres work.

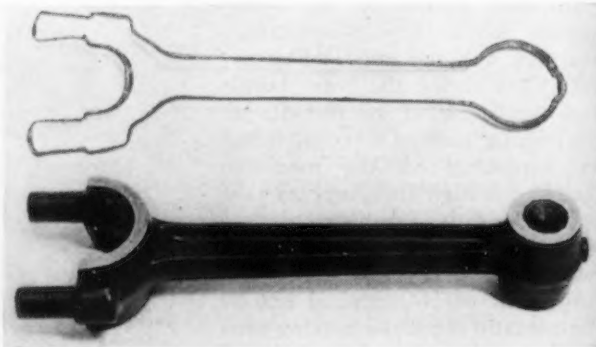


FIG. 10

**M**ALLEABLE casting with bosses and lugs accurately finished on Maxipres.



essary in these production units. These designs permit rapid repair or changing of minor parts, and it is very infrequent when a breakdown of a major nature affects the production routine."

Importance of the drop forge industry in forging parts uniform in size that makes possible large production on automatic machines from forged blanks and the efficiency of the coining press as a tool for high speed production of parts that cannot be produced economically by machining and which otherwise could not be used because of prohibitive costs is stressed by A. C. Johnson, president, Rockford Drop Forge Co., Rockford, Ill.

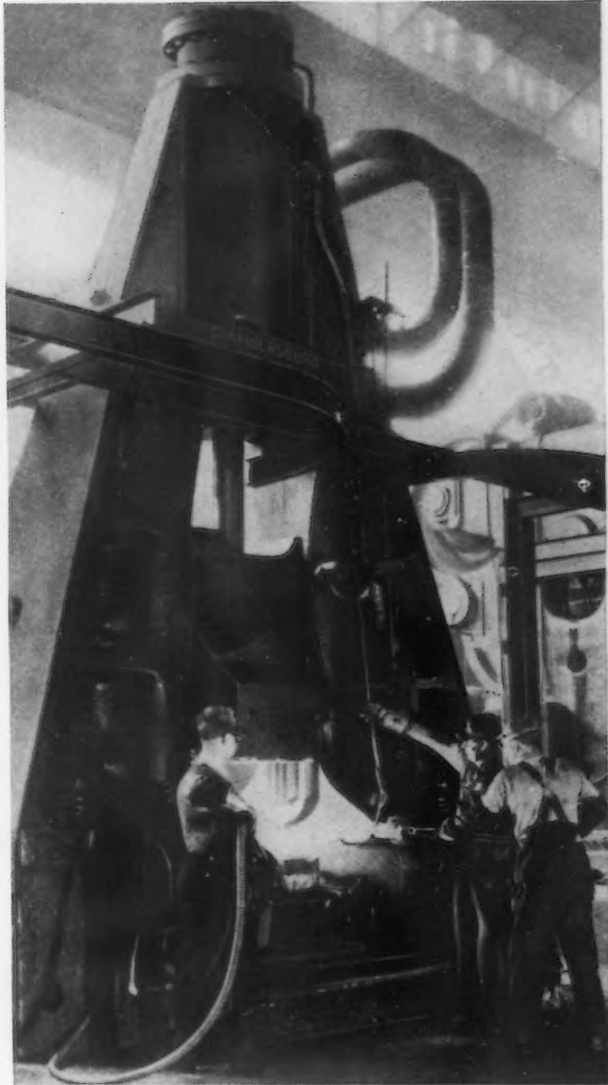
#### Close Dimension Forging

"Many articles have been written describing the almost human and gigantic performance of the automatic machine," stated Mr. Johnson. "It has played a vital part in the promotion of mass production. Much credit is due and should be given to the inventive genius of the machine builders. However, the automatic machines have limitations. Uniform sizes and shapes are required before an effective and efficient production can be attained.

"In advance of the building and operation of the machine comes the lowly drop forger. In order that the wonderful machines may turn out hundreds or thousands of finished parts today in place of the dozens of yesterday, the drop forger with his technique and ingenuity must produce parts shaped to such uniform size as will be acceptable for automatic production.

"The illustration, Fig. 6, shows

FIG. 11  
ROUGHING out a  
Buick 8 crankshaft  
on 12,000-lb. Chambersburg hammer.

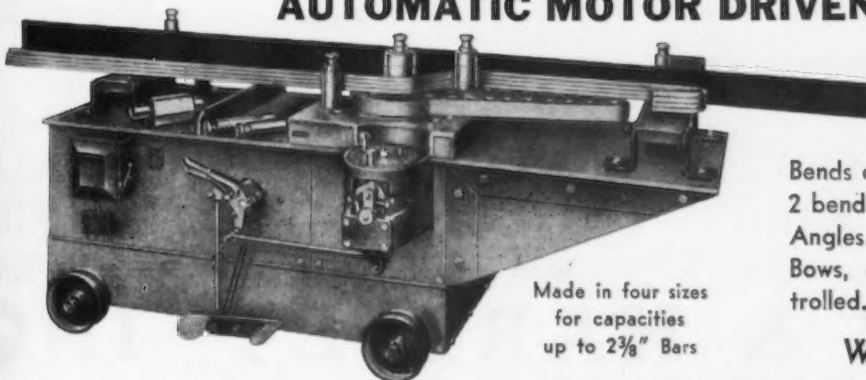


a few designs that are entirely out of the machineability field. The automatic or skilled mechanic is unable to produce these finished

shapes with his method of machining at a reasonable or economic cost.

(TO BE CONTINUED)

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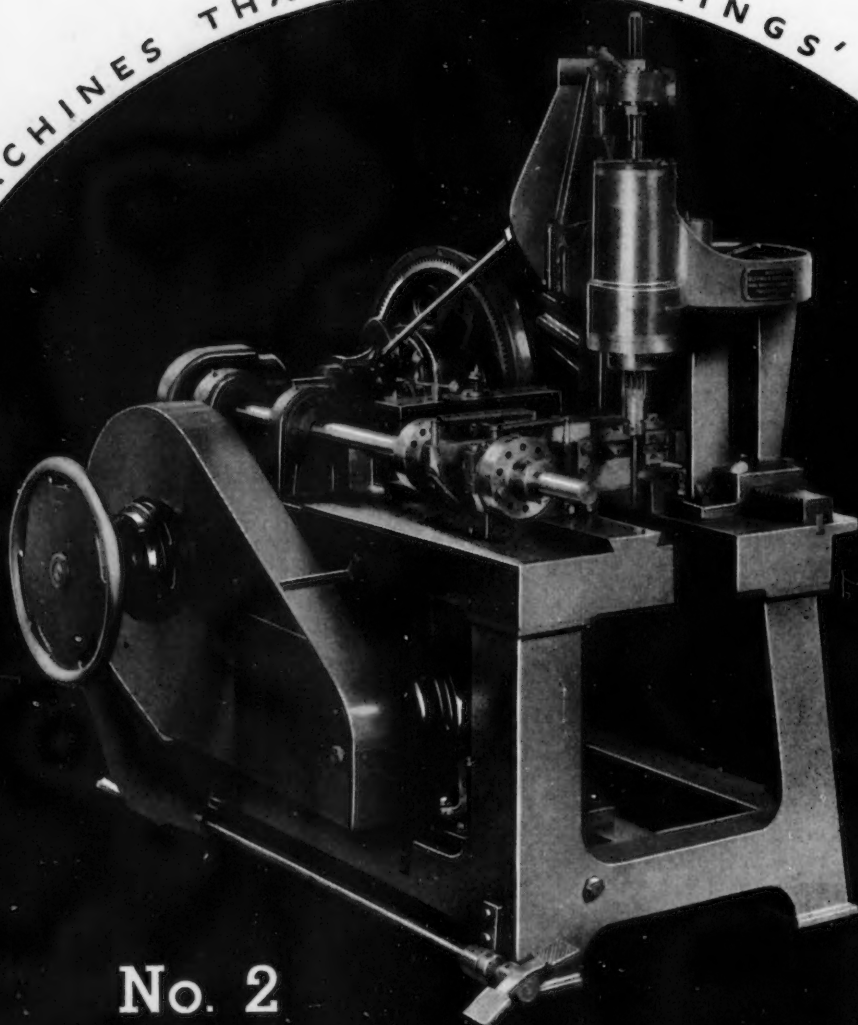
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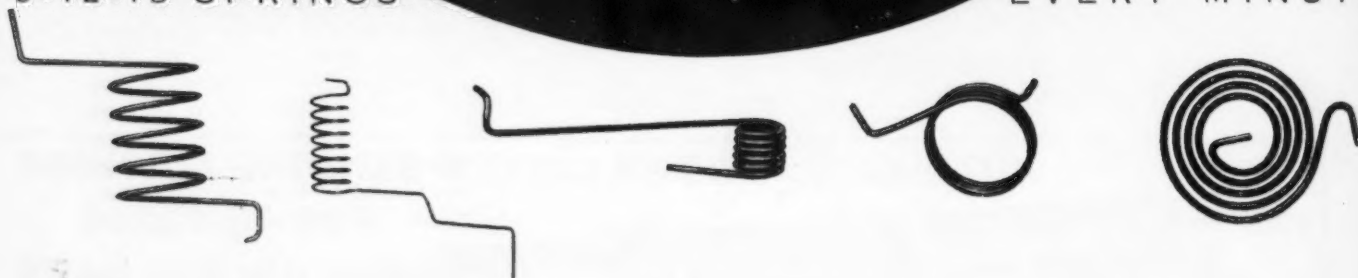
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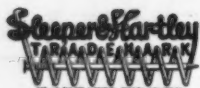
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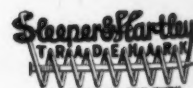


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# PRESSES AND SHEET METAL MACHINERY

*Improvements in hydraulic as well as mechanical presses, combined with advance in methods and materials, have added to this large field.*

By O. P. HATTON

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IN a day when almost every group of commercial enterprise finds it advantageous to make the public "conscious" of its existence, the pressed metal industry is so nearly inarticulate that few men know the extent of its penetration into every walk of life. Yet all the Thousand-and-One-Nights' Tales together do not contain one-half the romance which flows through this seemingly humdrum industry. Functioning since the very beginning of man's climb upward from the brute, providing him with ten thousand unquestionably accepted means for better living at this end of the long vista, the pressed metal industry gives to us all today a greater variety and an infinitely larger volume of both necessities and luxuries than any other method of production known.

## General Lines of Progress

This article then must be a record of the bringing to completion of many previous steps of partial development. As it is assembled, the facts naturally align themselves under eight heads. It will be in the order of this natural alinement that the data in this annual review of the pressed metal industry will be presented.

It is probable that the new developments recently made in hy-

draulic presses will prove to be epoch-making. They have interposed, midway between the extremely rapid, mass-production type of mechanical press, and the traditionally slow, powerful and cumbersome hydraulic machinery of past years, a new version of the latter in which the inherent virtues of both types are combined to an extent that cannot fail to provide a new impetus toward higher quality and greater speed in production. This is the most definitely "new" development in the industry.

As a matter of fact, the pressure on the industry exerted by the depression has worked both ways from the middle. While, in the one direction, it has tremendously speeded up the production rates of its machinery, it has

worked quite as forcibly in the other to reduce the minimum quantity of product which can be turned out economically. Where minimum units of production were formerly reckoned in the tens, or even hundreds of thousands, it is quite practicable today to operate in units of hundreds or even less. Two of the factors which have contributed to this end are: (1) the development of new types of low-cost dies, and (2) the newer types of hydraulic presses which have made the use of these lower cost dies possible.

Equipment makers have definitely adopted a policy of refinement in both the mechanical features and the general appearance of their machinery. The use of high-test, hard surface alloy castings has become general, providing

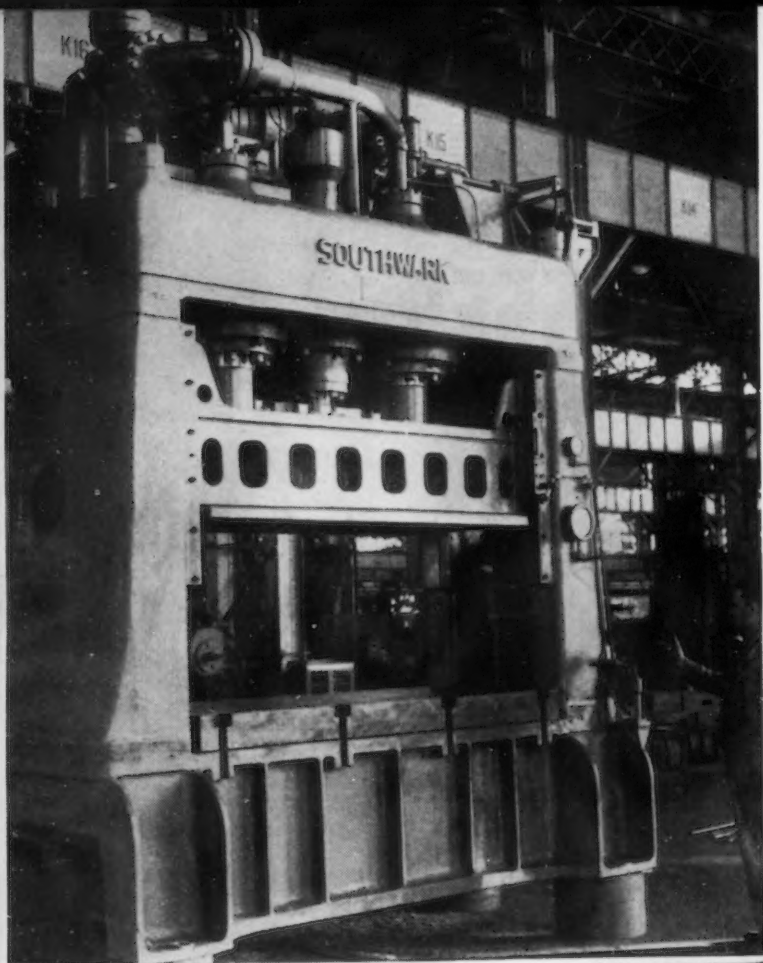


FIG. 1—AT LEFT  
**B**ALDWIN -  
SOUTHWARK  
single - acting hy-  
draulic press.

FIG. 2—BELOW  
**B**ALDWIN -  
SOUTHWARK  
double - acting hy-  
draulic press.

both a greater factor of safety and at the same time a more workman-like design of equipment. More efficient clutches and controls, dies, and such auxiliary mechanisms as feeds and coiled-strip handling devices, are being provided. Enclosures of working parts, and the "smoothing-up" of frame construction have progressed so far that there is little resemblance between some of our more modern presses and those of a decade or two ago.

#### New Fields of Endeavor

The pressed metal industry has always been searching out new fields of endeavor, and turning preconceived notions of how a thing should be made upside down; as well as making possible the production of a great many things which could not be made practicably in any other manner. The reduction of minimum quantities mentioned above has figured to an important degree in the production of aircraft and in the construction of the new light-weight streamlined railway trains. The new plastics industry is completely dependent upon the forming press, and borrows many of its procedures from the developments in pressed metal

equipment. A major portion of the food industry owes its vast growth to the facilities in rapid can-making production developed by pressed metal methods. And scores of other industries have in the past year felt the beneficent effects of pressed metal methods in the lowering of their production costs.

The present situation in New England, first home of the pressed metal industry, and in the Middle West, where automobile production has stimulated the conception and construction of such gigantic monsters of mass production as form single sheets of heavy steel into complete "turret-tops" for automobiles — both deserve brief reviews of current trends in development. And finally the moot question of "Art in Industry" has a very special application to the pressed metal field today, and must be briefly recognized.

The adaptability of mechanically

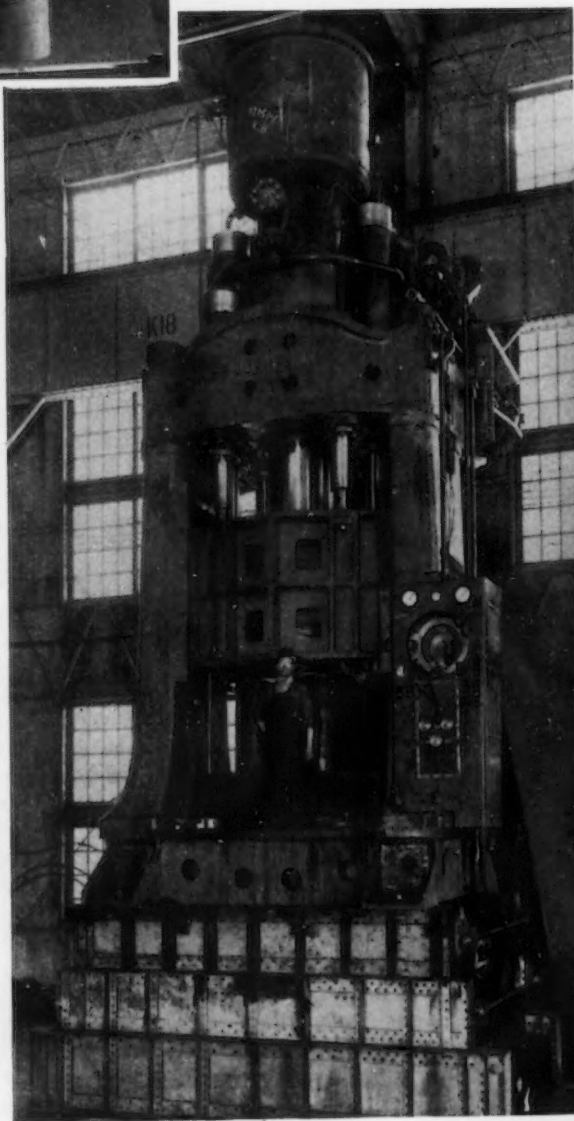
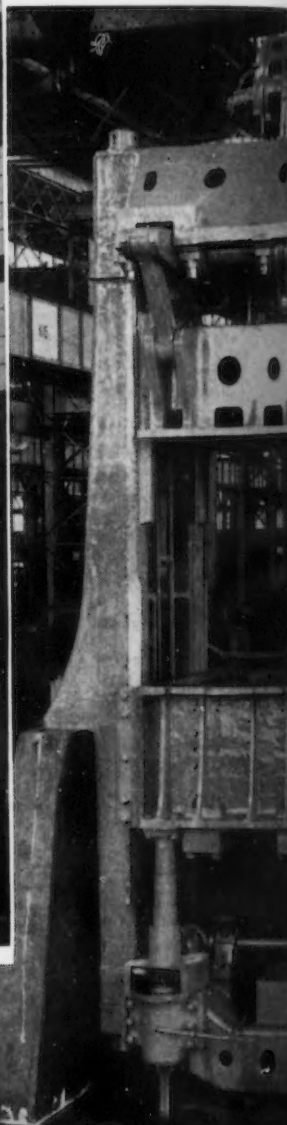


FIG. 3  
**B**ALDWIN - SOUTHWARK



driven presses to high production rates has always been conceded, despite certain limitations and disadvantages which have been largely overcome from time to time as experience and sound engineering pointed the way. Progress, therefore, until very recent times, has been almost wholly in the field of mechanical equipment.\* Hydraulic presses held grimly to their natural work of the slow-speed forming of large, heavy and deep-drawn sheet metal items.

But there were certain qualities inherent in the operation of hydraulic presses which could not be found in their mechanical brethren, and designers have labored long and arduously to hold these qualities in a type of press which would at the same time attain that quality of speed so essential to mass production work. The past year has witnessed the perfecting of such a new industrial tool. The

° ° °

FIG. 4—BELOW  
**BALDWIN**  
**SOUTHWARK**  
light capacity balanced stroke, fairly high speed hydraulic.

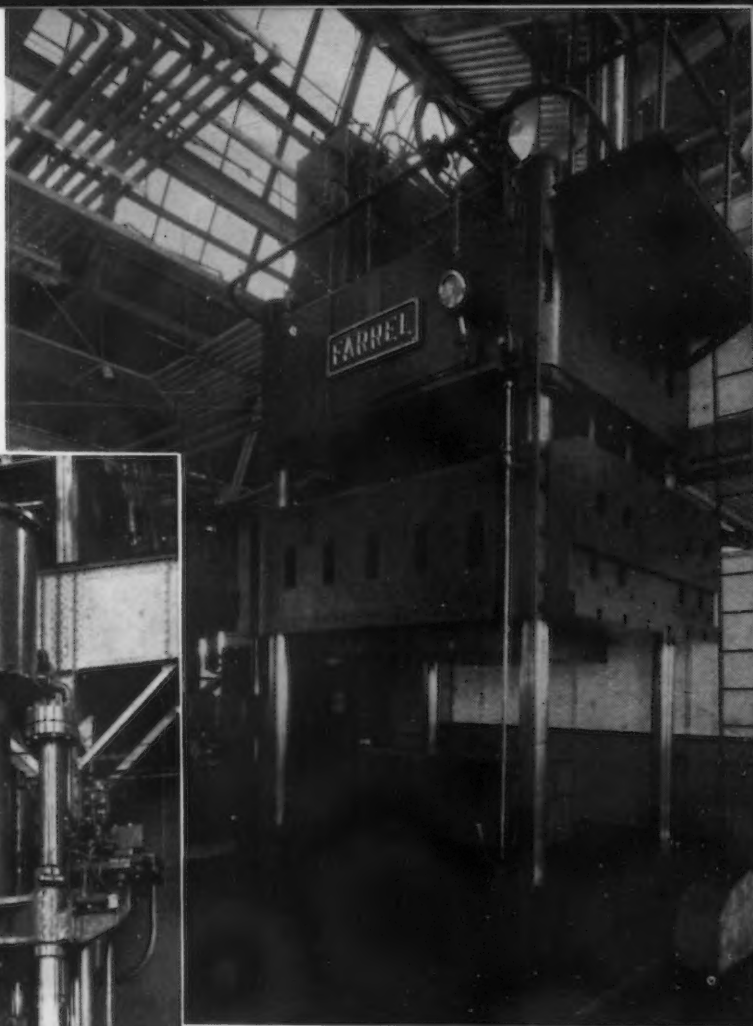
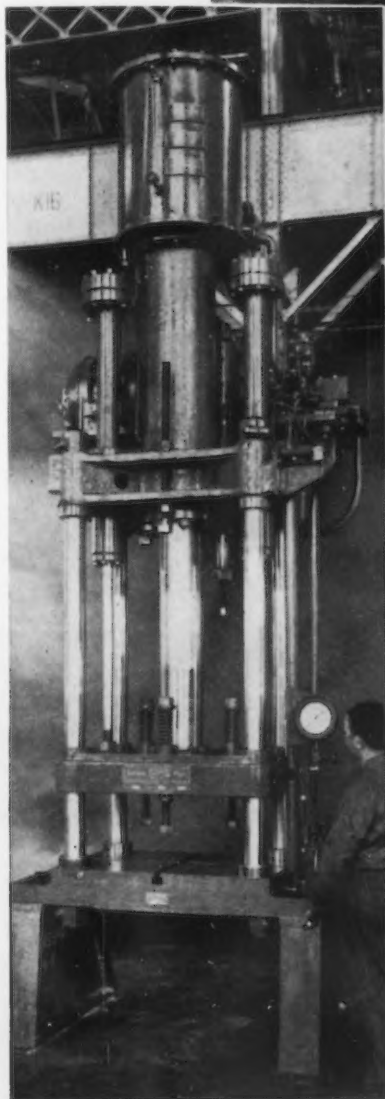


FIG. 5—ABOVE  
**ARREL-BIRMINGHAM** 500-ton hydraulic for the forming of duralumin aircraft parts.

° ° °

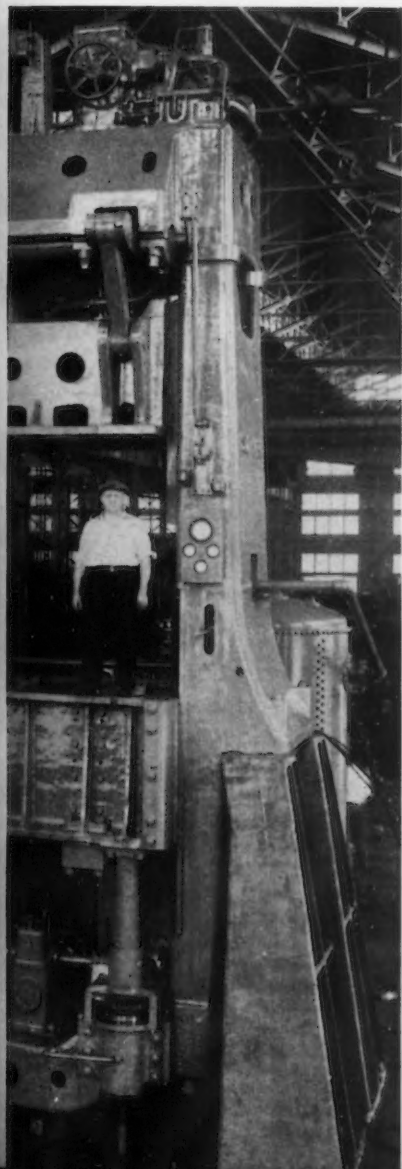
medium depths of draw and medium speed requirements are concerned. In this common territory the modern hydraulic will share production with the mechanical press, and will eliminate, where it is desirable because of the character of the work, the disadvantages under many operating conditions of the inflexible mechanical stroke. Likewise, since the hydraulic press is better adapted for the use of the less durable and less expensive types of dies, it is ideal for use under minimum production quantity conditions which call for the making of a smaller number of pieces than is found economical with the mechanical press.

The development of this new tool is not wholly, of course, a product of 1936. Two essential elements were required. The first one, the direct connected variable delivery rotary pump, has been available in other industries for a number of years. The second, quick-acting, sensitive control de-

power, flexibility and infinite delicacy of control inherent in the hydraulic press have finally been combined with quickness of operation in a compact, self-contained, independent unit capable of relatively high-speed production.

This new tool, the modern hydraulic press, is taking over a large part of what may be termed the mid-section of the industry. Retaining its always normal capacity for handling deep-drawn work, it has now successfully entered the field where medium sizes,

triple-acting hydraulic press.



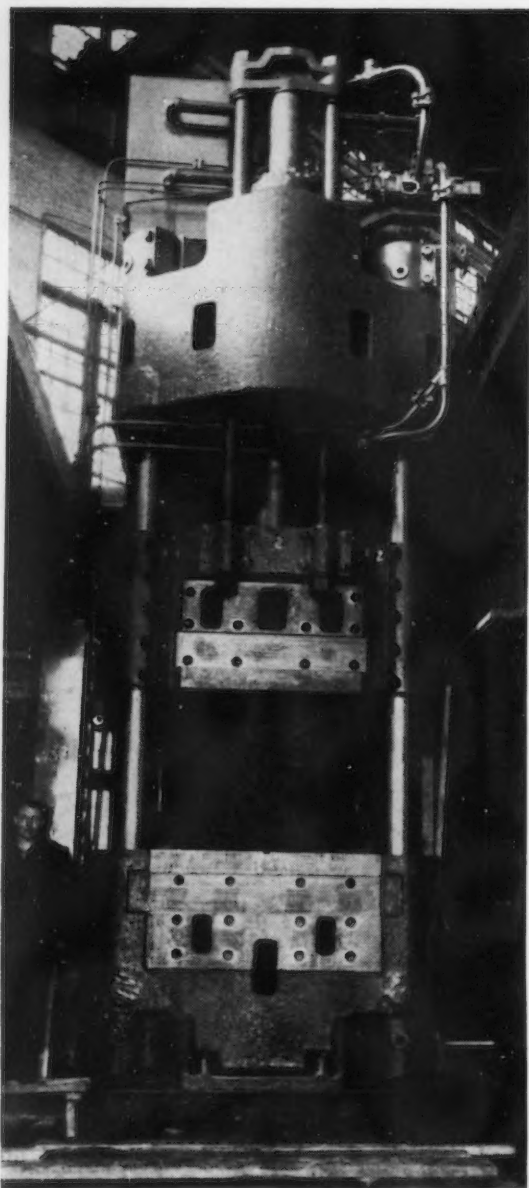


FIG. 6—AT LEFT  
**F**ARREL-BIRMING-  
 HAM 2000-ton  
 hydraulic built for a  
 Western aircraft  
 manufacturer.

o o o

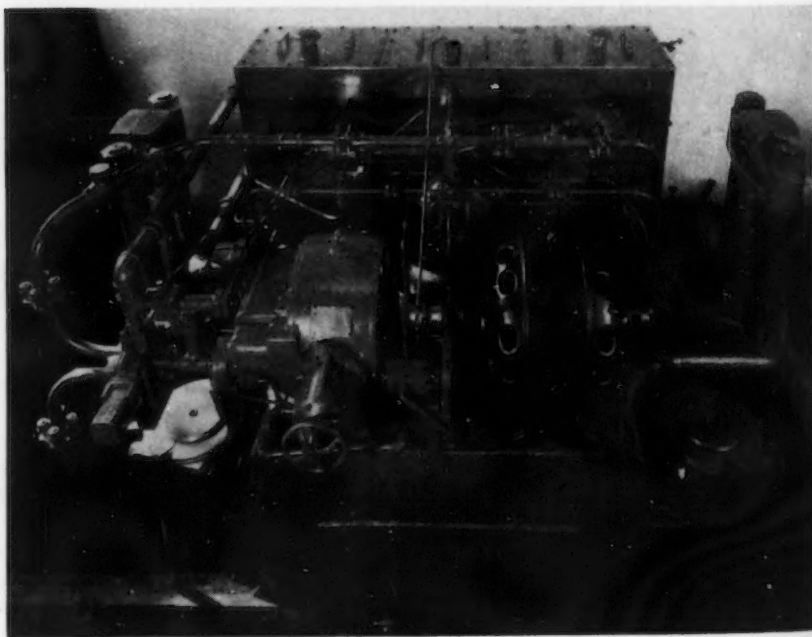
FIG. 7—BELOW  
**T**HE "top-works"  
 of the Farrel-Birm-  
 ingham 2000-ton hy-  
 draulic shown in Fig.  
 6.

press, with pressure exerted simultaneously from both directions. Both these presses are of the "straight" hydraulic type. In Fig. 3 a triple-action press is shown for such operations as require a reverse draw in addition to the main forming operation. This press is a toggle-hydraulic, combining both mechanical and hydraulic action. The heavier hydraulic presses are frequently made with two sets of pumps; one a light, fast-action pump to bring the ram quickly to the work, and the other a powerful, slower-acting pump which is cut in automatically for the real work of the press when the ram encounters resistance. Hydraulics may also contain air or hydraulic cushions in the bed to cushion the blow, and electric "feelers" to release the pressure at a predetermined point. Fig. 4 illustrates a light-capacity, balanced-stroke, single-action Baldwin-Southwark press capable of fairly high speed. In all these presses the characteristic difference between the modern hydraulic and the older types is evident. The bulgy and cumbersome accumulator, with its maze of piping, required by the reciprocating pump, has been replaced by the compact, direct-connected rotary pump, reducing materially the amount of space required for press operation. Likewise the newer, trimmer, streamline design is evident.

The two Farrel-Birmingham hydraulic presses shown are splendid examples of this new tendency to

vices have only recently been brought to the stage of perfection necessary to permit the rotary pump to be effectively applied to hydraulic press operation. And it has not been until the past year that both together have been properly adapted to the hydraulic press to serve a constantly increasing variety of requirements. A detailed presentation of the modern hydraulic press was given in *THE IRON AGE*, issue of Nov. 26, 1936.

Here it will be sufficient to present some typical additional examples of modern hydraulic press construction. Baldwin-Southwark Corp. furnishes this equipment in the three generally recognized types. In Fig. 1 is shown a single-acting press, in which the pressure is exerted from one direction only. Fig. 2 shows a double-acting



streamline the design of big presses. In both cases it is worth notice that the whole shape of the press frame may be contained smoothly within an imaginary figure bounded by rectangular planes. Not only is space saved thereby, but the neat, trim appearance suggests vast stores of reserve power for gigantic operations.

Fig. 5 illustrates a Farrel hydraulic forming press of 500-tons capacity installed in an airplane factory for the blanking and forming of duralumin aircraft parts. This press is of the moving-down type, with self-contained oil power unit mounted on top. The main ram is 24 in. in diameter. Two push-back rams of 6 in. diameter raise the moving platen to the open position. The entire control of the press is from a station located near a corner of the press, and consists of a foot pedal in combination with a hand lever to control the movement of the hydraulically operated valve. A push button is provided for operating the motor controller.

Fig. 6 shows a Farrel 2000-ton hydraulic forming press just prior to installation in an aircraft factory for blanking and forming duralumin parts. It contains one 28-in. and two 20-in. diameter main rams, and two 10-in. diameter push-back rams. This is one of the largest developments of the modern, rotary pump actuated hydraulic presses yet constructed. It is likewise evidence of the fact that aircraft construction is already a production industry of some size.

In Fig. 7 the top works of this same 2000-ton Farrel hydraulic are shown. Contrast this with the older reciprocating pump-accumulator maze of equipment with which the hydraulic has had to cope until recently, and it will be seen how much simpler the modern press is. An oil storage tank, a radial piston pump with a direct connected 100 hp., 585 r.p.m. motor, a limited amount of piping, and the control valves comprise the modern way of furnishing power to the press. Also shown here are

the push-back rams which return the moving platen to the starting position.

Fig. 8 illustrates one of the newest products of Hydraulic Press Mfg. Co. This Fastraverse hydraulic has a compound ram providing either 750-ton or 300-ton pressure capacity, as desired. Two-stage power units are used, and this particular press is especially adapted to deep drawing, such as long absorber shells for mechanical refrigerators, which have a completed depth of 16¼ in. The compound ram feature provides extremely flexible pressure applications in accordance with the job requirements of the shop.

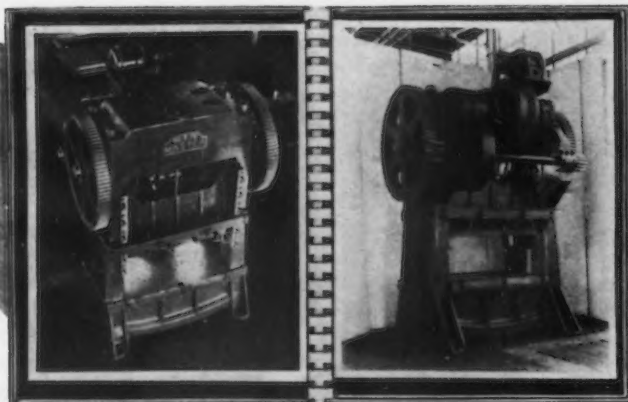
Fig. 9 shows an interesting example of the same company's three movement Fastraverse hydraulic press for deep drawing. The moving member of this press is a double arrangement, with two slides or platens in tandem. The main slide, above, carries the die punch while the secondary slide, below, carries the blank holder

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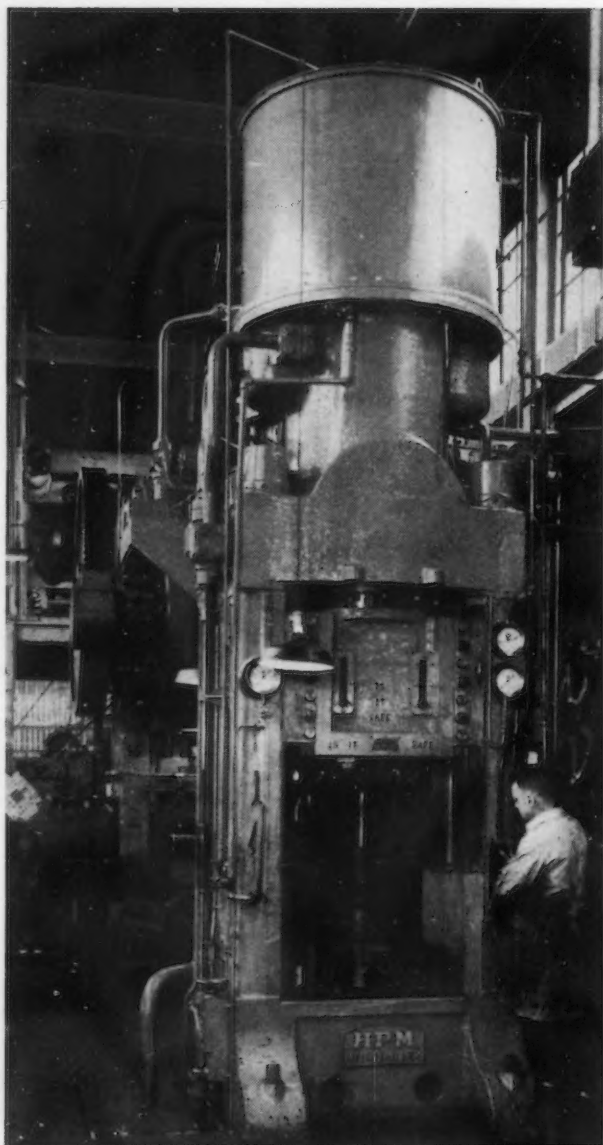


FIG. 8—AT LEFT

**H-P-M** Fastraverse hydraulic with compound ram for 750 and 300-ton capacities.

o o o

FIG. 9—BELOW

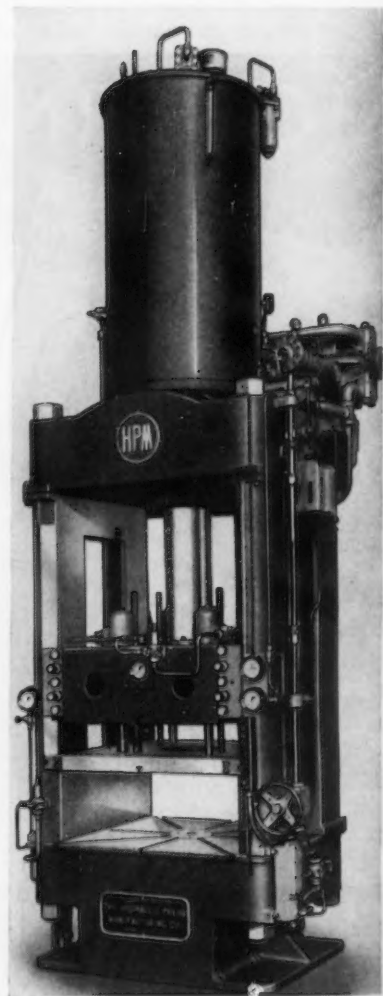
**H-P-M** Fastraverse triple-acting hydraulic press for especially deep drawing work.

Better steels, of more uniform metallurgical specifications and manufactured to more accurate thicknesses, are being produced. Perhaps the fact that some of the steel mills have provided blank-cutting service along with regular mill production may have influenced this factor. In the matter of press equipment there is a very definite trend toward greater refinement of design and accuracy of operation, as well as greater speed in the newest machines. It is now possible to produce fairly intricate items at the rate of 500 strokes per min., and by multiplication of dies to reach an actual production of 1000 or more per min. Another comparatively recent development is in new combinations of several production and assembly operations. An interesting example of this is the 25-ton Henry & Wright Mfg. Co. dieing machine (a precision automatic press having the crankshaft below the die-bed), as shown in Fig. 10, with automatic double roll feed

ring. An opening in the center of the lower slide clears the punch. The die-ring is mounted on the lower bolster plate. In the drawing operation the sheet metal blank is gripped between the blank-holder and the top surface of this die-ring, while the punch is forced down through the ring, drawing the metal with it. The blank-holding pressure is regulated so as to allow the metal to follow the draw without stretching or thinning, wrinkling or tearing. The third movement is accomplished by a slide within the bed beneath the bolster plate. Via pins passing through clearance holes in the bolster, this slide carries a movable die bottom working within the lower die ring, and serves to form up the bottom of the piece being drawn, including irregular contours. Separate rams move each slide.

In attempting to get a picture of the speed-up of production in the pressed metal industry one turns instinctively first to the Eastern States (and particularly to New England) where preeminence in the manufacture of small items is traditional. But the real picture today is a panorama sweeping across the entire country, and including not only the production of small units at tremendous speed, but swinging also through the whole gamut to the making of huge units requiring great power, at lesser speeds. While it is true that automatic, high-speed units have operated successfully for many years, 1936 showed them progressing to still more automatic functioning as well as to still greater multiplication of production rates, with no ultimate limits visible.

Many factors have contributed.



feeding right to left and automatic double roll feed feeding front to back. This type of equipment is for the production and assembly of small metal parts, and produces simultaneously two dissimilar items, automatically assembles them upon a third part, and stops automatically when a predetermined number of assembled parts have been completed.

Machines of this type with special auxiliaries make automotive radiator fins, producing two fins simultaneously from a single coil of 0.004-in. stock, slit and hemmed on one or both edges of each strip, and the fins corrugated by rolls. The baffle vanes are punched and raised to position, and the completed fins delivered from the press, two per stroke, making the production rate 260 per min. A further refinement is introduced by having the machine insert markers in each pile of delivered fins for the exact number of pieces required for a single radiator assembly, permitting the stock-handler to pick up with certainty the exact quantity required.

War, or anything approaching it, is a painful and delicate subject these days, but the pressed metal industry is doing its bit to be prepared—if! Small arms ammunition has always ranked close to the top of high speed production methods, but 1937 will be ready to produce whatever its needs may be with greater speed and accuracy than ever. Flexible metallic cartridge belts, for instance, designed for use with automatic rifles and machine guns, can be turned out almost as rapidly as the gun can fire the cartridges for which the belts are intended, on machines similar to that shown in Fig. 10.

Just how many different combinations of feeds, operations and assemblies can be arranged on one press hasn't yet been definitely settled. It is a very generous production schedule, however, that comes from the V. & O. Press Co. inclinable type press shown in Fig. 11. Four roll feeds furnish material for four separate items, which, after fabrication are assembled into one part by means of a dial feed, giving a complete assembly at each stroke after the initial cycle is completed.

When it seems undesirable to combine the entire cycle of operations in one machine either by

combinations of feeds or by progressive transfer dies, the modern shop couples two machines together with some form of automatic delivery system.

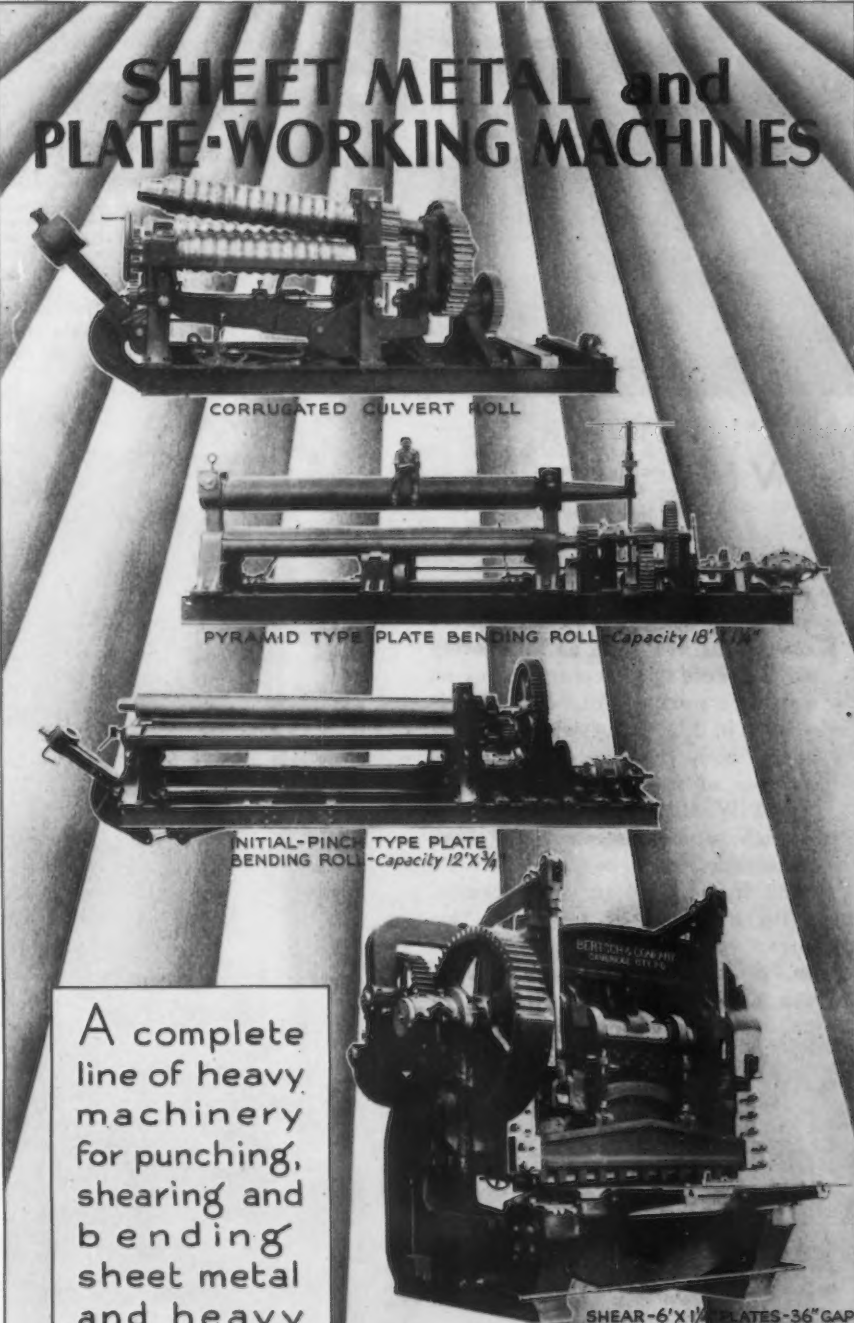
### Heavy Presses Speeded Up Also

Just as the small, rapid-fire "machine guns" of the pressed metal industry have advanced in speed, their intermediate and heavier cousins have been stepped up also. The heavier inclinable types

of presses, adapted to both roll and disk feeds, are handling heavier gages of metal than heretofore, and are working at higher speeds. Here the increased strength of material used in the machine castings is of importance. Many a 50-ton press rated for a normal speed of 80 strokes per min. may be pushed safely today to a speed of 260 strokes per min.

Production rates must necessarily be less as size and pressure

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CORRUGATED CULVERT ROLL

PYRAMID TYPE PLATE BENDING ROLL—Capacity 18" X 1/4"

INITIAL-PINCH TYPE PLATE BENDING ROLL—Capacity 12" X 1/4"

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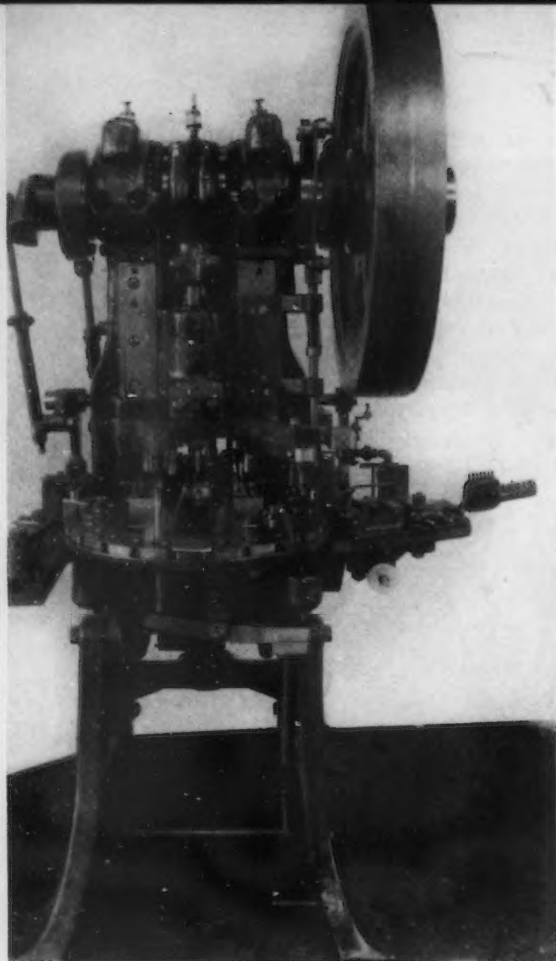


FIG. 11—ABOVE

V & O inclinable-type press, to make four items and assemble them into one.

o o o

increase, but to the industry the speed-ups being shown on heavier operations are quite as interesting as the more spectacular figures on smaller work. An example is shown in Fig. 12 of what is being done with heavy, single crank presses of the straight side type by E. W. Bliss Co. This is one of a high production series for fast, automatic work on metal up to 5/32 in. to 3/16 in. in thickness. With a rating of 200 tons, this press will handle coils up to 24 in. in width. The gearing is of the herringbone type, running in oil, the gear ratios being suitable for high energy storage. A pneumatic friction clutch is provided, with an electric control which can be interlocked with a set of electric safety feelers in the die. The operating speed may be stepped up as high as 100 strokes per min.

To skip from single to double crank presses with 8-in. and 12-in. shafts is just a normal stride in the pace of the equipment maker. With them today he provides double roll feeds, automatic air clutch controls and air cushions in the bed; all with speeds greatly

in excess of anything heretofore available.

Just about the biggest thing in big presses is shown in Fig. 13, put into operation late in 1936. It is a Bliss four point automatic blanking press, with two 8-in. crankshafts driving four cranks for a perfectly balanced slide stroke. It is used for automobile body construction, and is helped to quicker operation by special automatic feed devices. The available space between uprights is 210 in.; the double roll feed will handle 72-in. widths of heavy steel from coil cradles of 10-tons capacity, and it will feed 160 in. per stroke with precision. Just what its highest production rate will be can hardly be

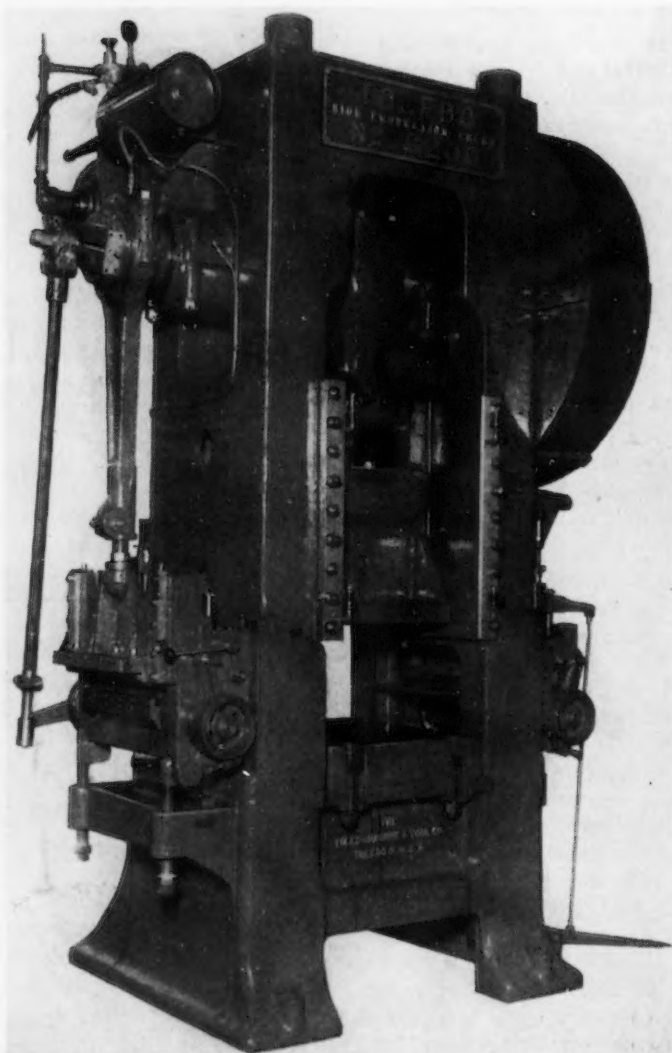
foretold yet, but it will undoubtedly chalk up another triumph for 1936.

Through all the stages of its development in recent years, the record of the pressed metal industry is a proud one. Although it dates back to the very dawn of human progress, the stage of its mechanization and consequent large contributions to our standard of living, is but a century old. Clearly within the memory of this generation the automobile began to assume its present shape. To this end mechanical and hydraulic presses contributed a major share. At the same time scores of other industries benefited equally from the developments in pressed metal technique.

The great war interposed a breathless period of high-powered effort, in which manufacturers learned through the medium of power presses more things about

FIG. 12

A HEAVY single crank Bliss press with an operating speed of 100 strokes per min.



mass production than even the most enthusiastic proponents of the industry had ever dreamed—things which it has taken years of peace time production to utilize to the fullest extent. Scarcely returned to a normal status once more, the industry encountered the depression. But even this misfortune it has turned to account. The challenge to find things that were salable even in the worst of depressions was met by widening the field of application of pressed metal methods, by speeding up the output of products, and by lessening the cost of the production of such goods.

The actions and reactions of a depression period upon industry in general are curiously unpredictable. We have recently heard a decidedly vocal school of economists urge a return to "pick and shovel" methods as a solution of the unemployment problem. Yet in the pressed metal industry we find that both makers and users of equipment have vigorously set about speeding up machinery of production.

With an amazing record behind them, they have simply used this

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record as a starting point from which to project themselves forward and upward to new heights of endeavor. And if this new speeding up of production be frowned

upon by some as inimical to the solution of the unemployment problem, all indications point to the fact that increased business at lower cost will more than take up the slack for which increased machine productivity may be responsible. (TO BE CONTINUED)

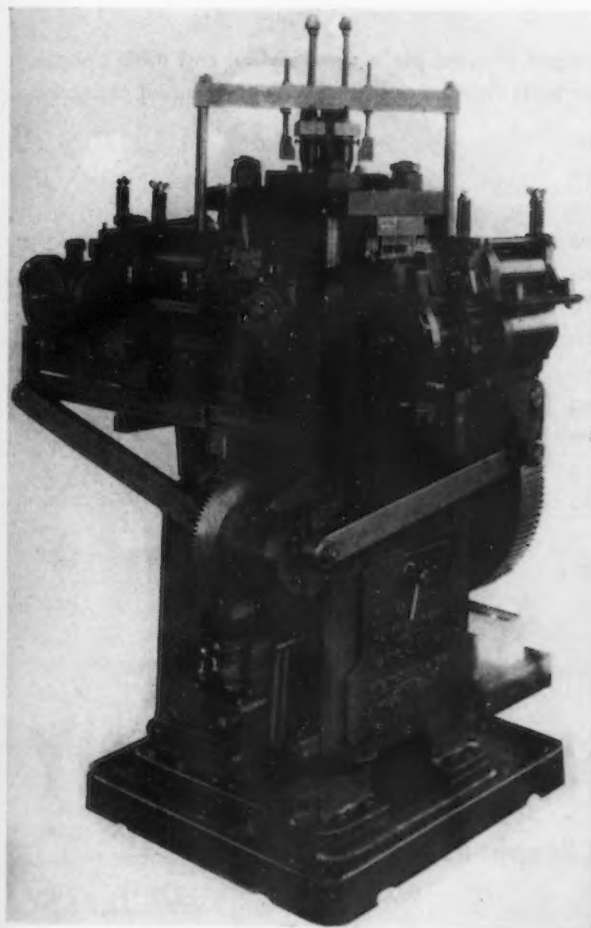


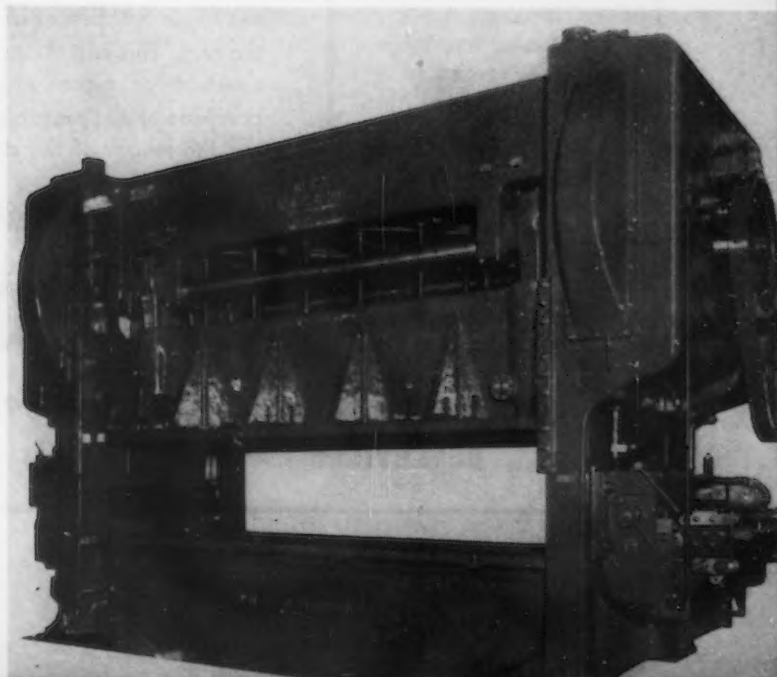
FIG. 10—AT LEFT

**H**ENRY & WRIGHT dieing machine, 25-tons capacity, for multiple operations.

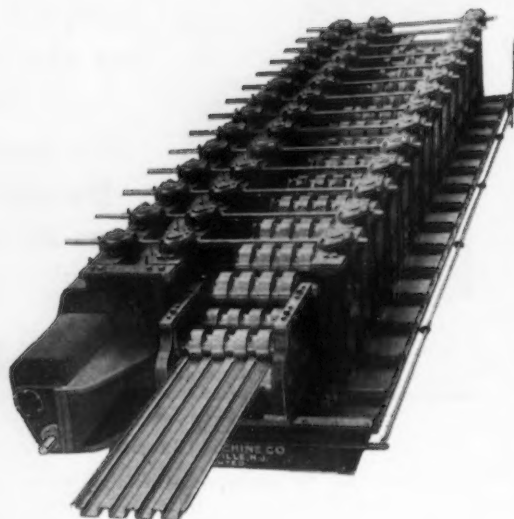
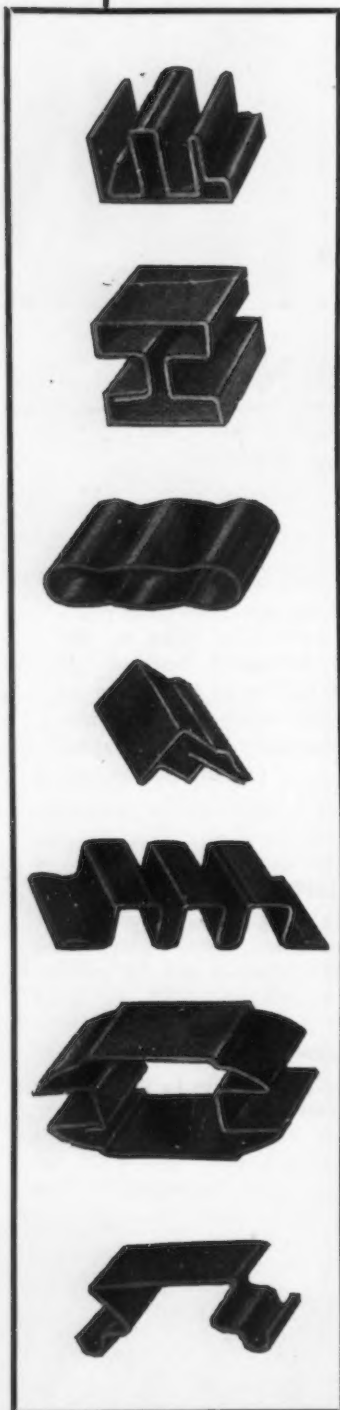
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FIG. 13—BELOW

**T**HIS Bliss four-point blanking press is said to be the biggest press in operation.



# The Highest Development in COLD METAL FORMING MACHINES



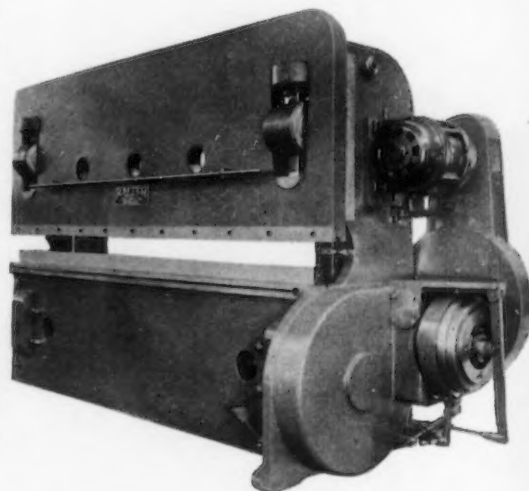
**T**HE Rafter Cold Metal Roll Forming Machines produce a wide variety of sections from relatively simple to highly complicated forms. They are made in a range of sizes to cover every requirement from small moldings to elaborate cornices and structural members.

These roll forming machines are truly production machines, turning out work at low unit cost, and among many exclusive Rafter features is one which provides for quick and easy roll changeover.

**A**BLE companions of the roll forming machines are the Rafter Press Brakes for an equally wide variety of forming operations where the number of pieces to be produced at any one time does not warrant the use of a continuous roll forming machine.

These Press Brakes are of rugged all-steel plate construction and have deeper and heavier rams and deeper beds than any other machines of equal capacity.

This is accomplished by an exclusive design feature which places the drive mechanism at the base of the machine so that it is not necessary to sacrifice ram or base depth to provide low headroom. This design feature also relieves the side frames of all driving stresses so that they perform the single function of guiding the ram. This and the rugged construction means absolute precision at all times throughout the length of the dies.



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# POWER TRANSMISSION

*Improvements in variable speed devices, the "Energy" drive, better belting technique and advances in electrification mark power transmission progress.*

By FRANCIS JURASCHEK  
*Consulting Editor, The Iron Age*

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• • •



SINCE all three of the major developments recently made in the field of power transmission equipment contain within themselves the possibilities of very widespread adaptation to present industrial drive problems, a somewhat more extended review of their mechanisms and functions will be given than of other developments mentioned in this summary. This is not done with any idea of belittling the worth of these other achievements, but solely because the potential advantages of the first three classes make it desirable to single them out as factors of decisive influence in the future planning of "the right drive for every machine."

The increasing importance of making available easily and accurately the exact driving speeds at which a machine will give the best and most economical production has led to extended research along the lines of apparatus designed to transform the economical speed of a motor to the economical speeds required by a machine, whether fixed or variable. Developments of this nature may be roughly classed as "speed reduction mechanisms," whether the motor speed is increased or reduced.

The need of a device which will tend to smooth out the variable load operation of machines which normally contain a heavy overload period in each operating cycle has led to the perfecting of a fly-wheel type pulley called the "energy drive."

The delays and difficulties incident to fitting large flat rubber belts to the job in the field has led

to a method of splicing such belts and vulcanizing them directly on the job; thus removing one of the principal objections to the use of rubber belting as a power transmission medium.

These developments are described in detail first. Later many other new devices, and notable improvements in present mechanisms are given brief comment as advances which have helped to make the subject of industrial power transmission of increasing importance during the past year to the industrial executive who has his mind set on economical production methods.

## Speed Reduction Mechanisms

Under this head may be included three types of mechanism: Devices which produce infinitely variable speeds from a constant speed motor, with the motor and the mechanical speed-changing mechanism

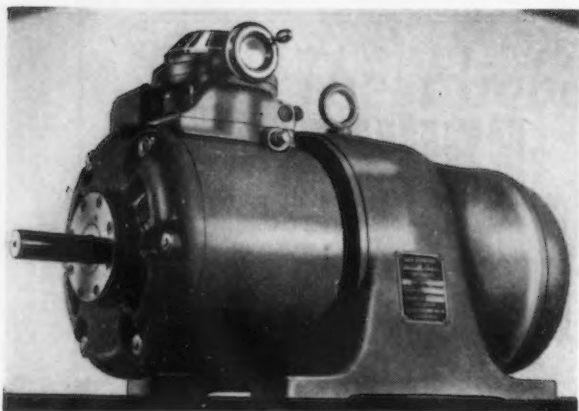


FIG. 1—The Transitorq transmission.

ism built as an integral unit; devices which produce infinitely variable speeds mechanically, but are not assembled with a motor as an integral unit; devices which produce fixed speed reduction (or increase) from an integrally-built constant speed motor. In each of these types the past two years has witnessed great technical advances.

#### Variable Speed Motor Transmissions

The Transitorq, manufactured by the New Departure Mfg. Co.,

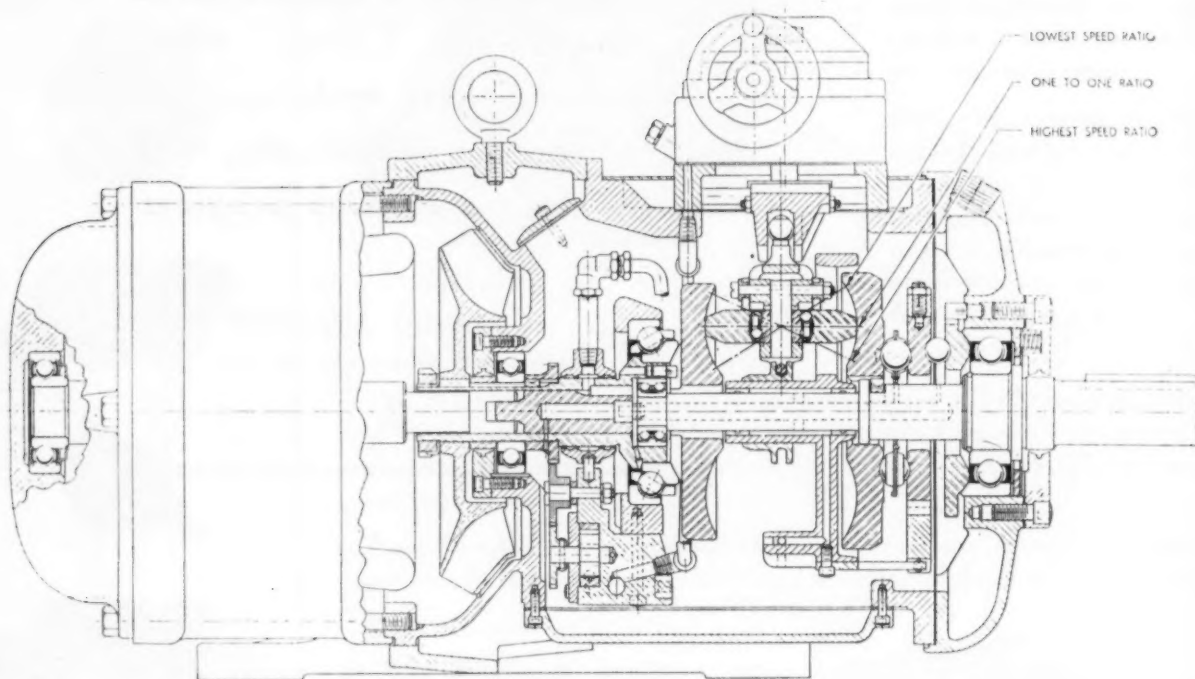


FIG. 2—Longitudinal section through Transitorq transmission.

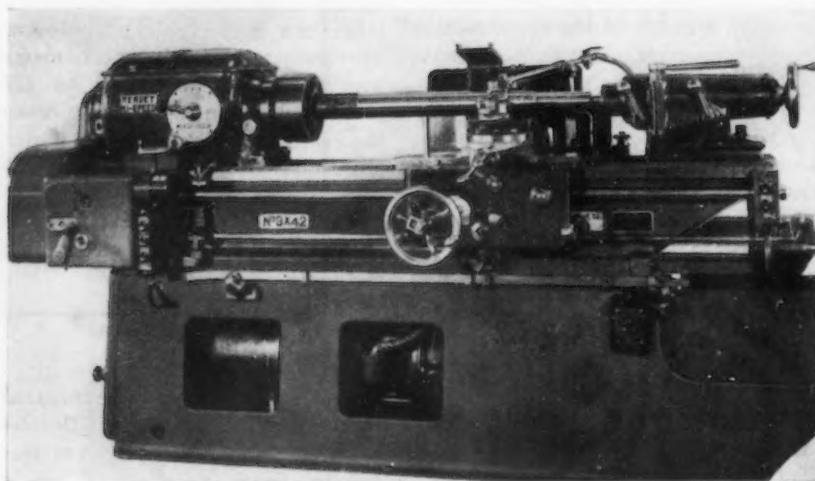


FIG. 3—Transitorq driving high-speed step-turning lathe.

is a unit combining a constant speed electric motor with a mechanical transmission, the output speed of which is infinitely variable over its entire range. Basically the transmission of power is effected by means of hardened steel rollers in contact with hardened steel races. Since the positive transmission of power by this principle depends upon the pressure of the rollers on the races being kept proportional to the input or output torque load, an essential feature of the Transitorq is an automatic pressure device which utilizes the imposed torque load itself to generate and maintain the required pressure between rollers and races. This device is so sensitive to the slightest pressure changes in im-

posed torque that the roller contact pressure is held positively under conditions of continuous, variable or shock loads, in definite proportions to the transmitted load.

Fig. 1 shows a typical Transitorq transmission as built with any standard make of motor. The construction of the device shows three roller plates mounted in a non-rotatable spider, so arranged that they can be rocked a limited dis-

FIG. 5—Graham variable speed transmission.

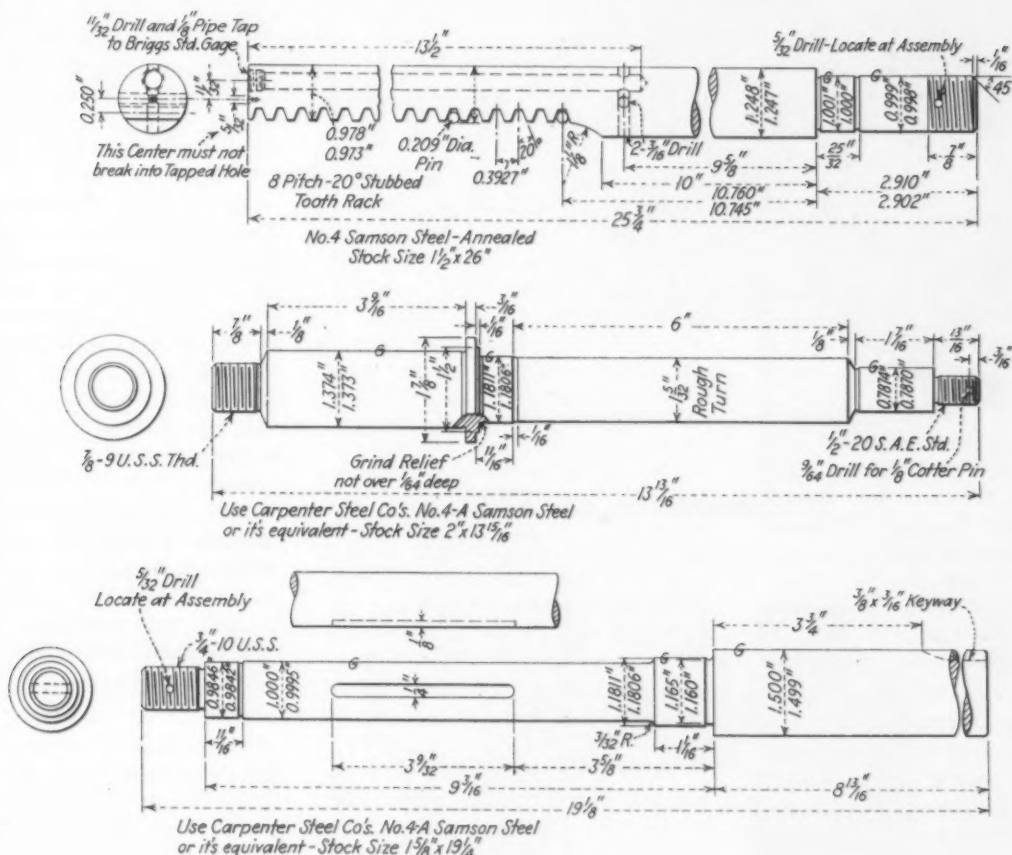


FIG. 4—Three jobs done on lathe in Fig. 3.

tance about an axis at right angles to the axis of rotation. Fig. 2 is a longitudinal section through the transmission, clearly indicating the position of the rollers with respect to the races. One portion of the faces of these rollers is always in contact with the constant speed input race connected to the motor shaft; another portion, 180 deg. distant, is always in contact with the variable speed output race, connected to the shaft to be coupled to the driven machine. The position of the rollers with respect to the two races determines the variation in speed between motor shaft and driven shaft, and rocking them from one position to another gives

an infinite variation within the limits of the transmission range. To change the position at any time, even while the motor is running, it

is simply necessary to turn a small handwheel conveniently located on top of the transmission case.

Fig. 3 illustrates an application

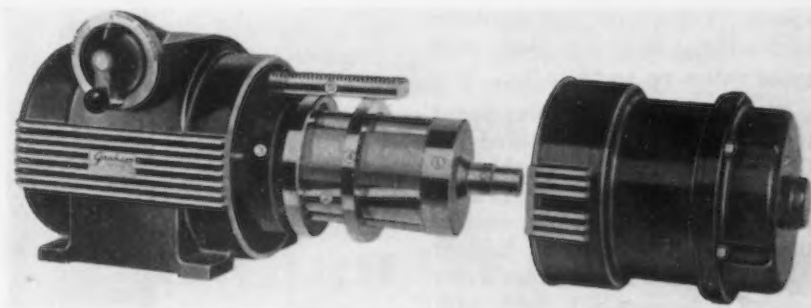


FIG. 6—Exploded view of Graham transmission.

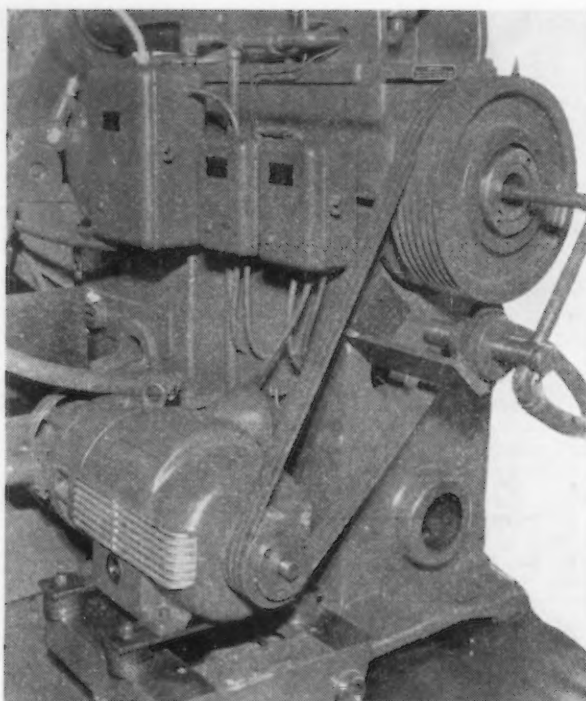


FIG. 7—Graham transmission driving work-head of Bryant internal grinder.

of this device to a high-speed step-turning lathe. An interesting story in connection with this installation comes from the Hartford Special Machinery Co. In Fig. 4 are shown three jobs done on this equipment. The top piece with the rack in one end was turned from 1½-in. stock to rough finish size in 18 min., as compared with 60 min. as the best time on older equipment. The second job was turned down in 35 min. as compared with the former 90 min. The bottom job was turned in 25 min. as compared with the former 75-min. period of work. Ultra modern tool design, plus infinite flexibility of speed control permitted these impressive reductions in production time. The variable speed power unit feature enables the operator to select exactly the number of revolutions required for a given cut. With older equipment, he was forced to choose the next lowest in a limited range of speeds. Transitorqs are available in fractional to 20-h.p. sizes, with speed ratios up to 10 to 1.

The Graham variable speed transmission is manufactured for Graham transmissions by the Fellows Gear Shaper Co. It is a straight-line motor-and-transmission unit in which three tapered rollers held in a carrier cage carry beveled pinions which mesh with a ring gear connected to the output shaft. A contact ring and

rack, whose position may be varied by a control wheel and pinion, encircles the tapered rollers to vary the output speed. This control may be manual, remote, or automatic, and a single turn of the control wheel gives infinite speed control, from motor speed to zero and reverse. It is claimed for this device that it combines the functions of an infinite speed variator, a speed reducer, an automatic centrifugal clutch and a load-limiting device. It will give positive protection against overload without damage to the transmission. Fig. 5 shows

a typical Graham unit, and Fig. 6 shows the same unit "exploded," with the transmission case removed and the rollers, carrier cage and ring gear mechanism exposed.

Fig. 7 shows an application of the Graham transmission to a Bryant grinder, where it is used for driving the work ahead. The speed variation feature is of decided advantage in connection with the finishing of internal cylindrical work, in that by varying the speed of the work ahead it is possible to use the same grinding wheel for roughing and finishing cuts. Graham transmissions are available in fractional to 7½-h.p. sizes, with built-in, coupled motors, or with geared heads.

The Reeves Vari-Speed Motodrive is likewise a combination unit which contains in one compact, self-contained inclosure any standard make of constant speed motor and a variable speed mechanical transmission. The Reeves Motodrive may, in addition, contain speed reduction gears. It is manufactured by the Reeves Pulley Co. and is actually an adaptation of the well-known Reeves variable speed transmission. Infinitely variable speeds within predetermined limits are provided. Two designs are available, horizontal, and vertical, depending on the position in which the mechanical unit is set.

The operating principle of the Reeves transmission is that of a broad V-belt driving between two pairs of cone-shaped disks, which

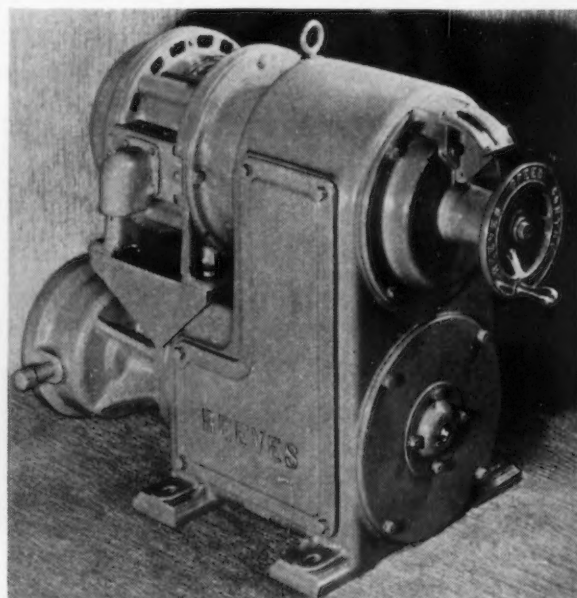


FIG. 8—Reeves vertical Vari-speed Motodrive with built-in speed reducer.

are adjustable to form, within limits, an infinite number of driving and driven pulley diameters. The disks are mounted on parallel shafts, one receiving power at constant speed from the motor, and the other transmitting power at infinitely adjustable speeds to any driven machine, as the V-belt assumes different diameters of contact against each set of disks. A conveniently mounted hand-wheel varies the diameters of belt contact with the pulleys. Fig. 8 illustrates a typical vertical unit with built-in speed reducer gears, and Fig. 9 shows a phantom view of the same with the various parts identified. Either vertical or horizontal units may be had for motor ratings from fractional to 10 h.p. covering a range of speed variation up to 6 to 1. Reduction units of the helical gear type in ratios up to 189 to 1 can be incorporated as desired.

A simplified form of the Reeves transmission is available in a variable speed motor pulley designed for direct mounting on the shaft of a constant speed motor. Through handwheel control the sliding motor base is moved forward or back while the driving diameter of the pulley disks is varied, effecting speed changes up to 3 to 1.

#### Fixed Speed Motor Transmissions

This class of unit is generally known as "gearmotor." It consists of an integrally built constant speed motor and a fixed speed mechanical transmission, usually gearing. Many of these mechanisms have been available for several years, but a few of the more recent developments should be briefly noted.

The Ratiomotor, manufactured by Boston Gear Works, Inc., utilizes a worm and gear type of reduction in such a manner that the unit may be run equally well in either direction. Some of the motors may be reversed instantly; others must be slowed down to  $\frac{3}{4}$  speed before reversing. Ranges are from 1/20 h.p. to 3 h.p., with gear ratios up to 40 to 1.

An interesting application of the Ratiomotor to a Buss Machine Works double surfacer is shown in Fig. 10 (the machine with gears in phantom before the Ratiomotor was installed) and Fig. 11, as the machine appeared with the Ratiomotor set in place. The new transmission device displaced a 20-tooth

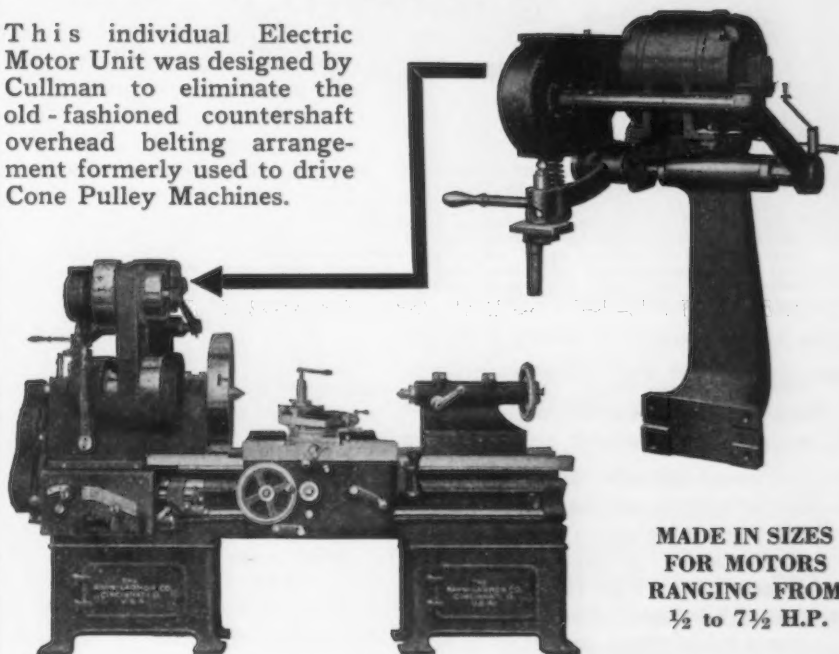
pinion on the feed motor, a 57-tooth gear connected to a 12-tooth pinion meshing into an 84-tooth gear on the crossfeed shaft. The surfacer manufacturer says of this installation, "Tests show at least  $\frac{1}{2}$  h.p. saved at 1200 r.p.m., and about  $\frac{1}{3}$  h.p. saved at 900 r.p.m." The Ratiomotor used is rated 25 to 1 ratio, with a 2 h.p., 1200 to 900 r.p.m. motor.

The Wagner gearmotor manufactured by Wagner Electric Corp.

in fractional horsepower sizes is illustrated in Fig. 12. This is a compact, single reduction right angle drive unit with an output speed of 30 r.p.m. and motor speed of 1725 r.p.m. These units are made in single, double and triple reduction parallel shaft types, and single and double reduction right angle drive types, all with interchangeable mountings. Fig. 13 shows a typical application of the Wagner gearmotor to a very slow

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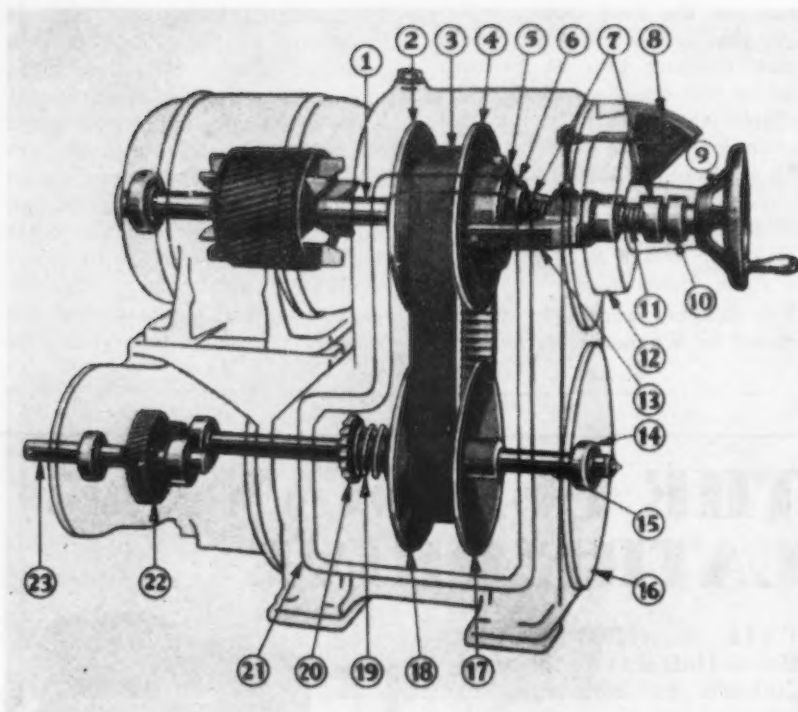


FIG. 9

Phantom view of vertical Motodrive with speed reducer showing parts which are standardly designated as follows: (1) Constant speed (power input) shaft; (2) fixed disk on constant speed shaft; (3) special molded V-belt; (4) adjustable disk on constant speed shaft; (5) equalizing collar; (6) disk thrust bearing; (7) stop nuts; (8) speed indicator; (9) speed control handwheel; (10) shifting screw thrust bearing; (11) speed shifting screw; (12) shifting screw cover plate; (13) shifting yoke; (14) frame cartridge bearing; (15) variable speed shaft; (16) frame bearing plate; (17) fixed disk on variable speed shaft; (18) adjustable disk on variable speed shaft; (19) belt tension spring; (20) belt tension adjusting nut; (21) inspection plate; (22) speed reducer; (23) output shaft.

speed belt conveyor. The output speed is less than one-half revolution per minute.

General Electric Co. gearmotors are, of course, well known, and are serving a wide range of industrial applications. A typical unit is illustrated in Fig. 14, in the so-called "skeleton" frame. A few newer installations are shown herewith. In Fig. 15 a 30-h.p. G. E. induction type gearmotor with normal starting torque and low starting current characteristics, reducing to 17 r.p.m. is driving a drawbench for copper tubes, producing more uniform tubes than heretofore possible. Fig. 16 shows a G. E. gearmotor of the direct current built-in type, rated 20/40/40 h.p. at 89/178/287 r.p.m. adjustable speed, driving a wire-drawing block. Fig. 17 shows a G. E. squirrel cage, 2 h.p. 600 r.p.m. gearmotor flange-mounted on a crankshaper, providing a very compact, simple and direct utilization of power. Gearmotors made by other manufacturers, notably Westinghouse, Crocker-Wheeler, Philadelphia Gear Works and the Falk Corp., are successfully working in many similar services, pro-

viding a wide range of industrial applicability with minimum power losses and compact design.

#### Mechanical Speed Change Mechanisms

Aside from the Reeves variable speed drive, described above in connection with the Reeves Vari-Speed Motodrive, the principal developments in mechanical variable speed mechanisms are the P.I.V. drive and the Vari-Pitch sheave.

The P.I.V. drive is a product of the Link Belt Co. It is named from the initial letters of the words Positive, Infinitely Variable. It consists of two pairs of opposed, conical, ribbed disks, between which a chain of special design with projections fitting into the ribs of the disks, transmits power. The effective diameters of the pulleys formed by each pair of disks can be altered under load to change the speed ratio, without steps, and without depending on friction. On changing speed the self-adjusting chain rises or falls between the sets of disks forming the pulleys, so that while the input shaft connected to the source of power turns at constant speed, the output shaft

speed is infinitely variable within the limits of the range of the transmission. Changes in the effective diameters of both pulleys are made by turning a handwheel mounted on the side of the enclosing case. An indicator shows the speed of the output shaft. All elements of the unit are built into and protected by a compact oil-tight housing, and are automatically splash-lubricated. Speed changes may be made easily, smoothly and accurately while the mechanism is in operation. Fig. 18 shows a phantom view of this device.

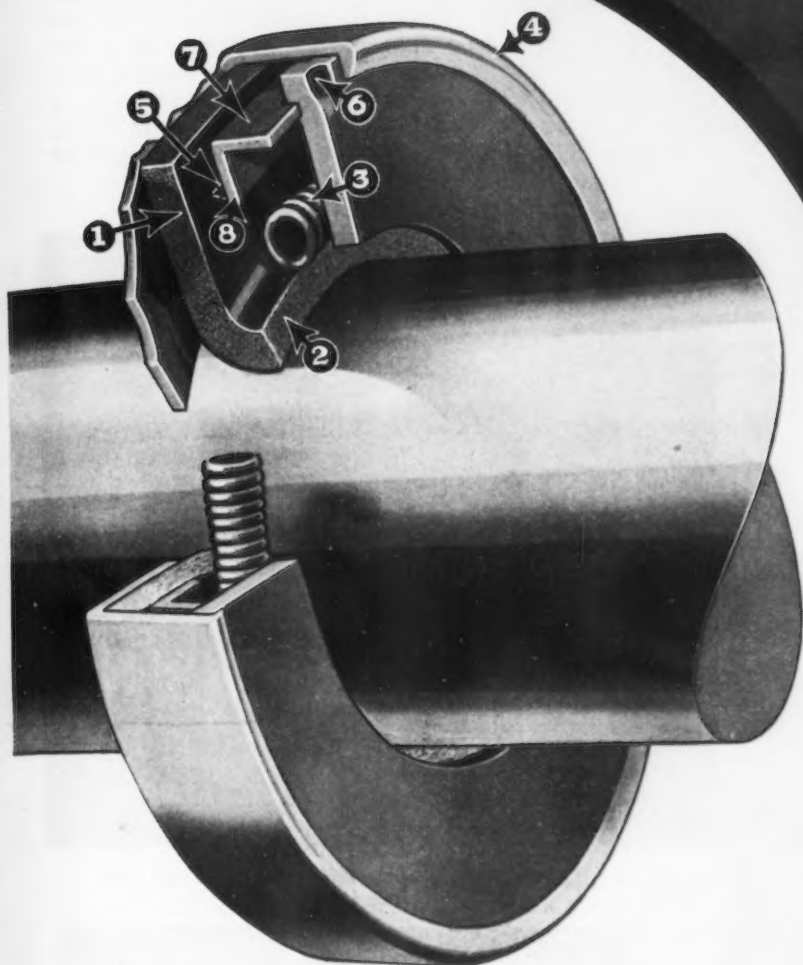
The Allis-Chalmers Mfg. Co.'s Vari-Pitch sheave is in many respects similar to the Reeves Vari-Speed motor pulley. It is a V-belt drive with the sheaves so arranged as to permit adjustment of the width of the grooves, so that the belts will run higher (or faster) and lower (or slower). It has a range of speed reduction of 15 per cent to 25 per cent per sheave. For infrequent speed changes, made while the sheave is stationary, a "stationary control" speed change type of sheave is used, and the groove adjustments are made manually. For speed changes required while in motion, a "motion control" type of sheave is used, with a "Strait-Line" motor base, in which the turning of a handwheel increases or decreases the pitch diameter of the sheave on the motor shaft and simultaneously moves the motor backward or forward on the base to maintain proper belt tension and compensate for the slight change in center distances of both sheaves. Fig. 19 shows this latter combination transmission device.

#### The Energy Drive

The second major development in industrial power transmission equipment is the so-called Energy Drive of the Power Transmission Council. The term is somewhat of a misnomer, for the device is not a drive, nor does it produce energy. Yet its importance is far beyond such captious criticism, and although its application has as yet been confined to textile looms, there is little reason to doubt that its use will shortly be extended to include other types of machinery where smoothness of operation affects the quality and the quantity of production.

Essentially the energy drive is

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Goods Exclusively • • • NEW YORK • PHILADELPHIA •  
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**1 PACKING MEMBER**—Leather continues to prove its superiority as an oil sealing material. Self lubricating, non-abrasive, durable, unaffected by oils or greases, it is flexible, yet non-plastic. Perfect Oil Seals are also furnished with compound packing members but only for those isolated applications where high static temperatures (higher than 250° F.) or the chemical reactions of fluids being sealed, are incompatible with leather.

**2 WIPING LIP** effectively prevents passage of lubricant or the entrance of foreign matter.

**3 TENSION SPRING** exerting pressure at wiping edge holds packing member on the shaft and automatically takes up any wear. Shaft contact is thus maintained even with shaft misalignment. Spring tension scientifically developed for speeds and pressures of the individual application.

**4 OUTER CUP** encloses the entire assembly in one solid unit for a close press fit into housing assembly. Outside diameter centerless ground for accuracy.

**5 INNER SHELL** carries sharp bosses which penetrate the leather of the packing member to prevent its rotation with the shaft—an exclusive feature of the "Perfect" Oil Retainer.

**6 LUG** on the cover washer drops into a notch in the inner shell to further prevent rotation of internal members.

**7 INNER SHELL** properly spaces cover washer and the flange of the packing member to permit free action of the tension spring.

**8 FOOT OF INNER SHELL** positively clamps flange of packing member in the outer cup.

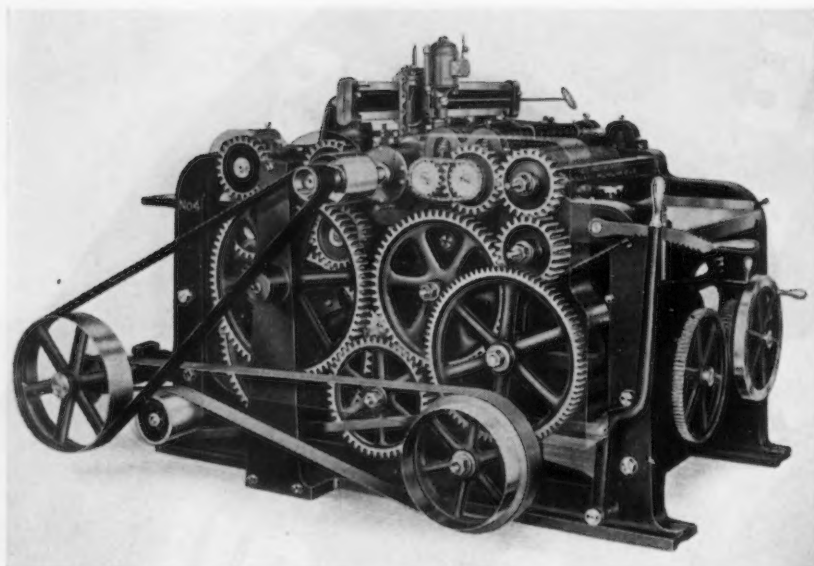


FIG. 10—Buss double surfacer as formerly equipped with gears.

a fly-wheel type pulley. Now, the function of a fly-wheel is to store energy at moments of intermittent power impulse, and to give up a portion of that energy in the periods between power impulses. The effect is to produce a smooth outflow of power. The function of the energy drive is the exact opposite. It absorbs load shocks at

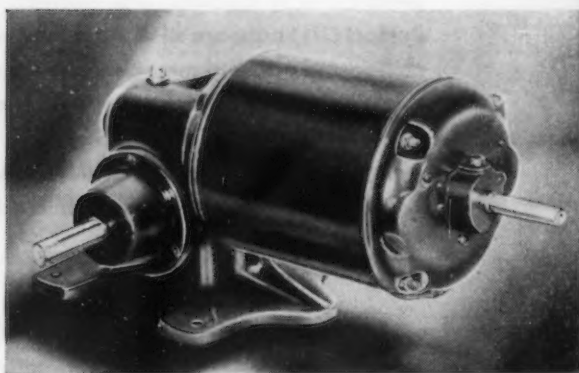


FIG. 12—Wagner fractional horsepower gearmotor.

moments of intermittent peaks, and by virtue of its inertia of movement carries the power to the machine smoothly. Thus, in either case the same result—a smooth flow of power—is produced by diametrically opposite effects, but by the same basic means. The inertia of a moving mass of considerable weight equalizes and averages the effect of intermittent blows.

A weaving loom develops a

highly varying load. The picker hits the shuttle once during each revolution of the loom pulley. This occurs during a small fraction of the time required for the pulley to make one revolution, but during its occurrence the load developed is many times that which is felt during the remainder of the pulley revolution. Whether the loom is belt or individually motor driven, this results in an unevenness of power delivered to the machine, since the sudden shock load causes the belt alternately to stretch and contract, or the motor gear and pinion to jerk. The inertia effect of the energy drive furnishes a simple and logical means to smooth out the application of power by

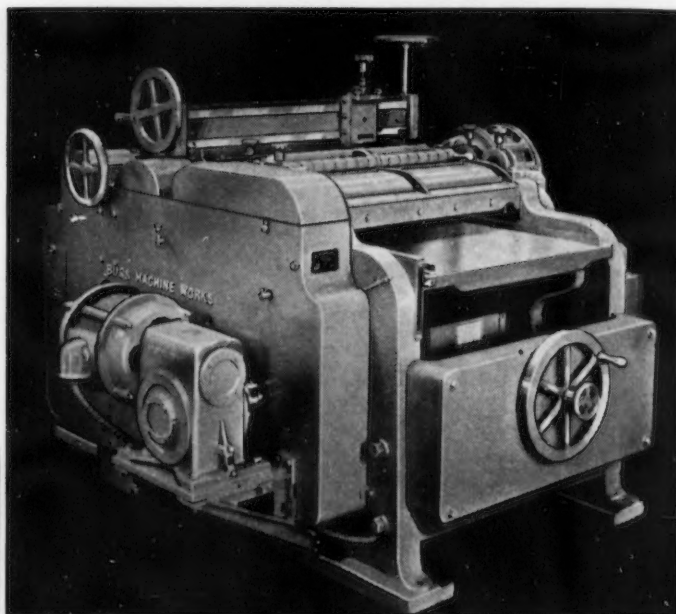
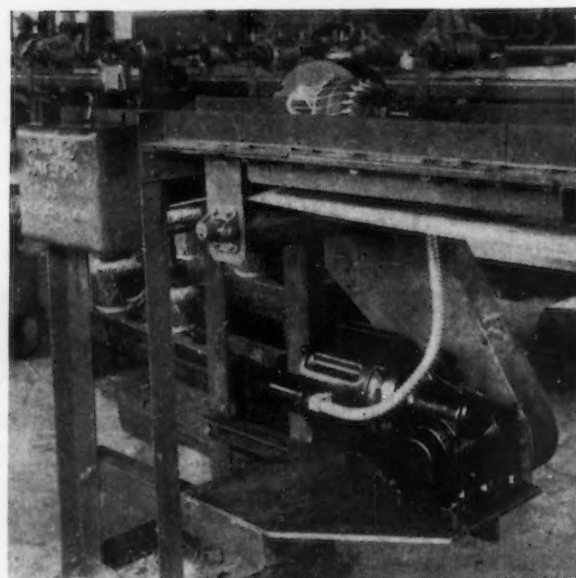


FIG. 11—Buss double surfacer as equipped with Ratiomotor drive.



AT RIGHT  
FIG. 13—Wagner gearmotor driving slow-speed conveyor.



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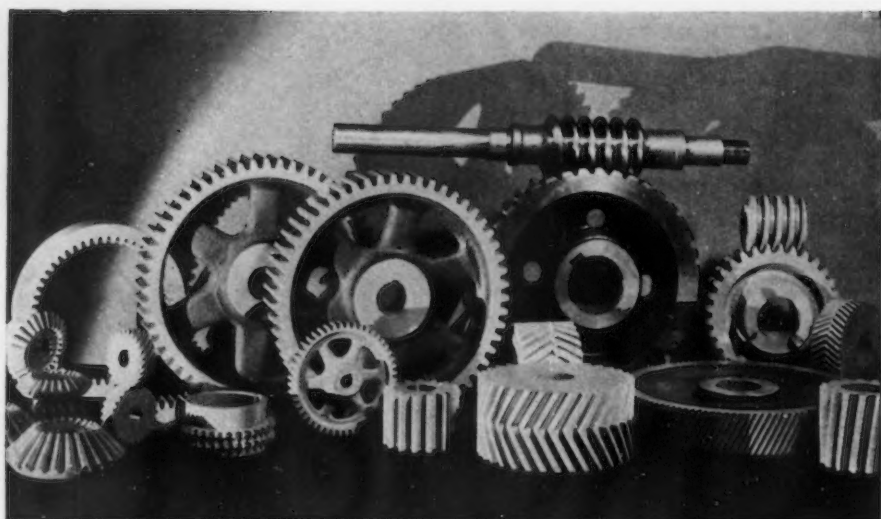
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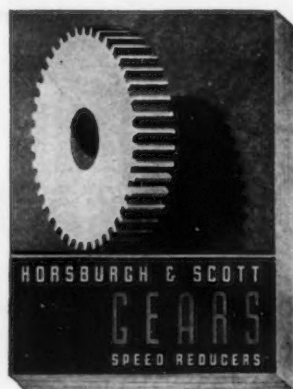


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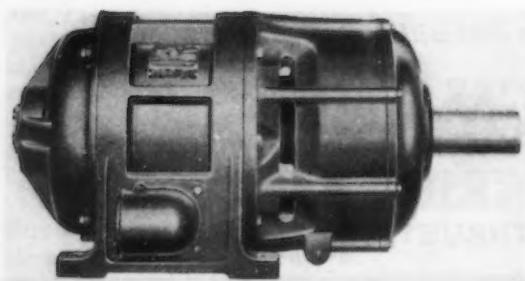
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○ ○ ○  
AT LEFT  
FIG. 14—G. E. gearmotor  
with "skeleton" frame.  
○ ○ ○

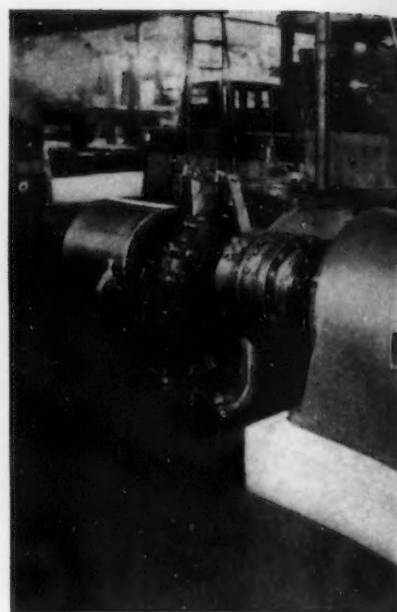


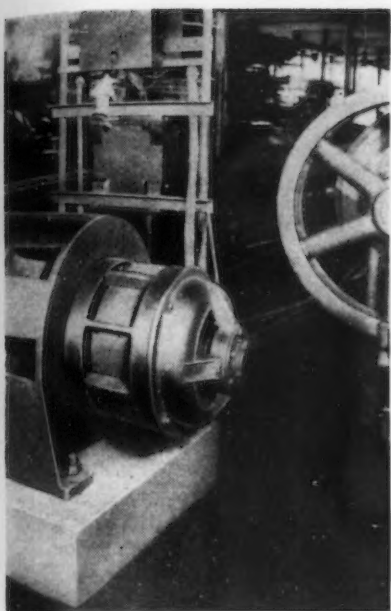
FIG. 15—G. E. gearmotor

absorbing this shock load; and by so doing makes possible the natural application of modern group drive to one of the largest classifications of machine to which the group drive principles of operation are inherently adapted.

The results of the application of the energy drive to looms has been amazing. Weaving is speeded up, so that increased quantities of

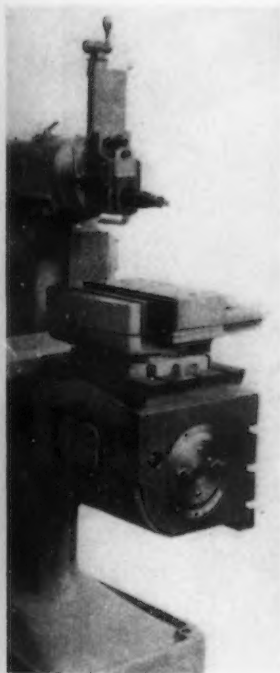


FIG. 17—G. E. flange-mounted



driving copper tube drawbench.

cloth are manufactured, and the quality of the cloth is improved. Of even greater importance is the fact that it effectually removes all the difficulties in the way of driving high speed looms by modern group drive methods. With energy drives such looms may be group driven at a total cost for electrical and mechanical transmission equipment approximately one-half



gearmotor driving a crankshaper.

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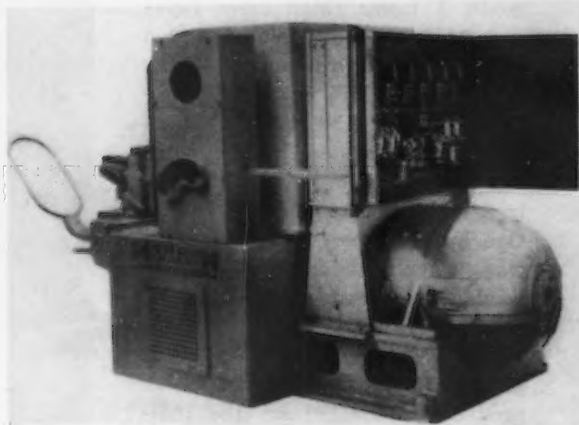
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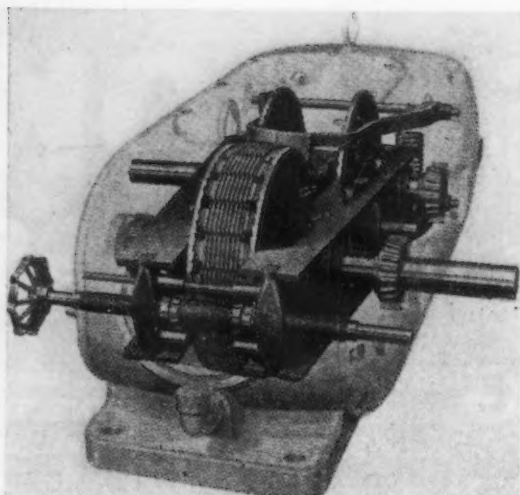
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AT RIGHT  
FIG. 16—G. E. gearmotor  
driving a wire-drawing  
block.





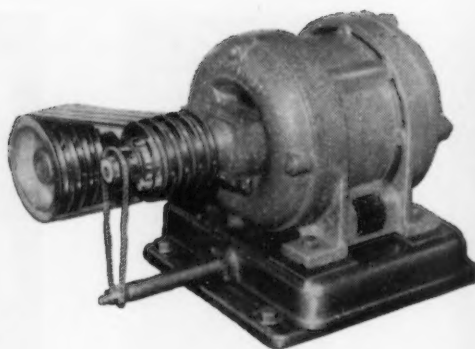
AT LEFT

**FIG. 18** — Phantom view of Link Belt P.I.V. transmission.

o o o

AT RIGHT

**FIG. 19** — Allis-Chalmers Vari-Pitch Motion Control Sheave drive.



that of individual motor drive, effecting a saving in transmission installation costs of about \$50 per loom. This, of course, is directly reflected in the annual operating costs. Thus, by reason of the advantages enumerated—increased production, improved quality of product, lower investment costs and decreased operating costs—the energy drive makes possible a larger margin of profit in textile operations. A number of important textile mills have already installed this device to advantage.

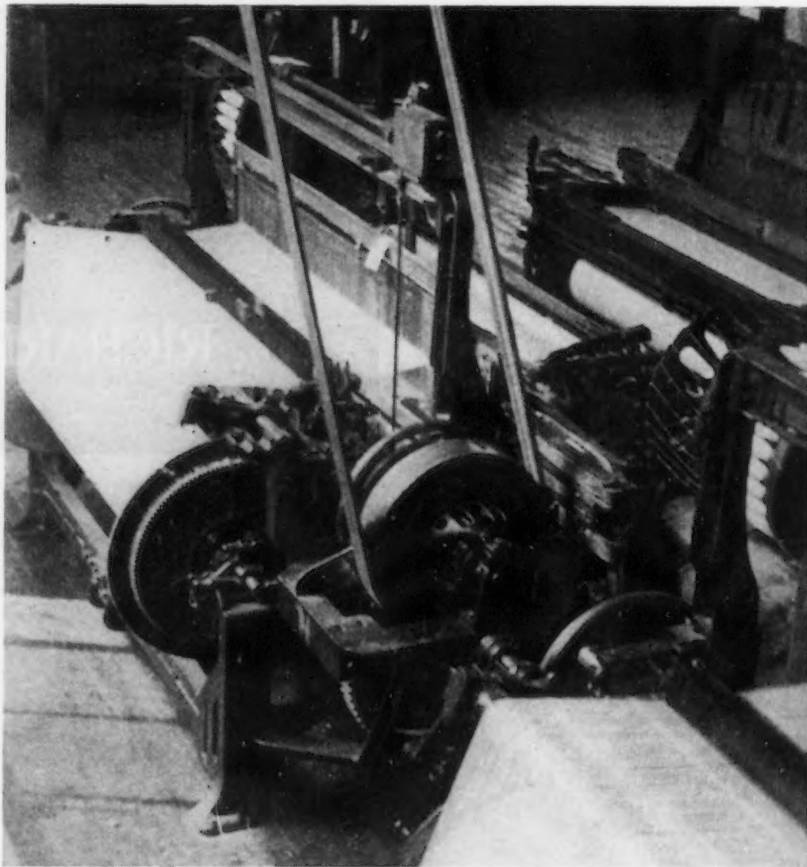
#### What Is the Energy Drive?

As shown in Fig. 20, the energy drive is simply a fly-wheel type pulley replacing the usual loom pulley if the loom is belt driven through a friction or clutch mechanism, or the large gear if the loom is individually motor driven. To utilize the energy drive, the loom must be operated through a friction or clutch mechanism. The weight of the fly-wheel pulley may be from 88 lb. to 110 lb. or even more, according to the type of loom on which it is installed. In a test conducted on 70 group driven model X looms (high speed type) and 70 individually motor driven model X looms over an eight-week period at 96 Mill in South Carolina, weaving the same kind of cloth and operated by the same weavers and loom fixers, comparative figures were recorded daily. One hundred per cent production was calculated as that which would have been obtained if all the looms ran continuously without a stop during the entire test period. The average figure for production obtained on the indi-

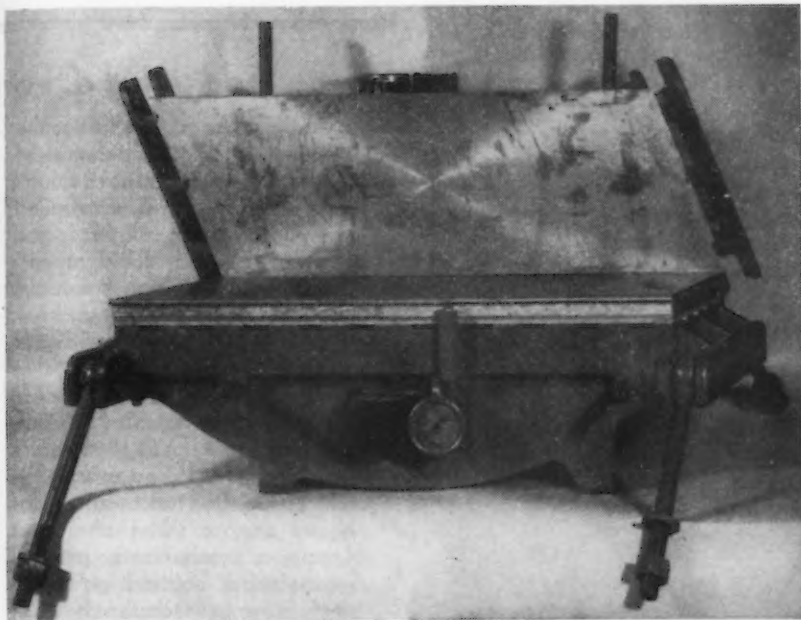
vidually motor driven looms was 96.85 per cent. This is an exceptionally fine production figure anywhere in the industry. But the production figure obtained for the group driven, energy drive equipped looms was 98.05 per cent! This is believed to be a record unattained by any other type of drive in the textile industry.

In another mill, a motor was removed from a single model X

loom which had been operated at 183 picks per min., weaving cloth to very fine specifications. An energy drive installed on this loom stepped up the speed to 196 picks per min. with a resulting operation that was more constant than before, and a noticeable reduction in "seconds" of the cloth produced. The accomplishments to date of energy drive installations in some 50 textile mills indicate clearly that a major change in methods of applying power to looms is now in process. Of even greater importance are the possibilities still latent in the application of the



**FIG. 20**—Power Transmission Council's Energy Drive on textile loom.



ABOVE

FIG. 22—Goodrich portable electric belt vulcanizer.

o o o

energy drive principle to machines in many other industries.

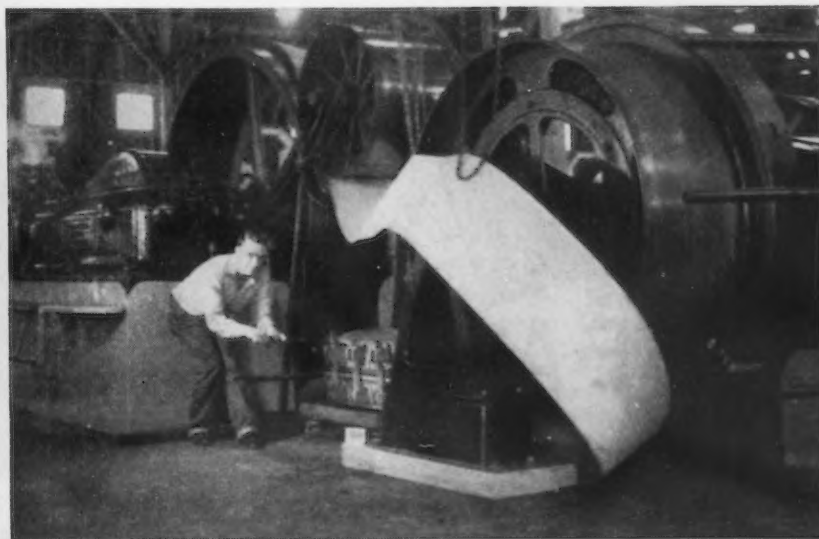
#### Splicing Flat Rubber Belt

The third major development in industrial power transmission during the past year relates to a newly perfected process of making flat rubber belt endless directly on

o o o

BELOW

FIG. 23—Typical Goodrich belt-splicing job done in the field.



the job. As worked out by the B. F. Goodrich Co., this comprises a new method of splicing such belting, and a line of portable electric vulcanizing machines.

Despite continual improvements in rubber belt structure, one great difficulty has always stood in the way of the unconditional acceptance of rubber belting in industry as a power transmission medium.



ABOVE

FIG. 21—Goodrich "Plylock" method of splicing rubber belting.

o o o

That difficulty has been to devise a practical way of making the belts endless on the job. The laced joint or the metal fastener has certain drawbacks, for continual flexing and pounding against the pulleys eventually causes such fasteners to break or tear away from the belt, increasing repair costs, to say nothing of the cost of shut-downs at inopportune times.

Until recently flat rubber belts

could be satisfactorily made endless only in the plant of the belting manufacturer. Two disadvantages were the result; delay in getting the belt to the job, and in many cases dismantling the drive to permit of the belt installation. The method evolved by Goodrich involves a new type of splice, called the "Plylock," made by cutting the ends of the belts in bias steps as shown in Fig. 21,

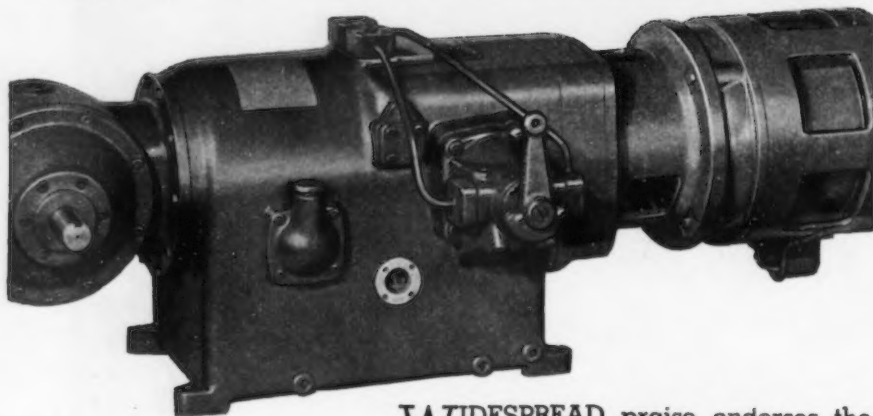
and making the ends of the plies interlock. The interlocking plies are then countersunk beneath the belt surface, the resulting depression filled with a reinforced rubber cushion, and the whole joint vulcanized with the portable electric vulcanizer shown in Fig. 22. The result is a smooth, strong joint without bumps or ridges. Tests show such a joint to have about 90 per cent of the strength of the

## Additional Develop

LACK of space forbade the printing of the balance of this article here. In next week's issue the story will be continued with descriptions of face and flange type end shield mountings for motors, high speed induction motors for direct drive, and motors for power factor correction; magnetic clutches and friction type mechanical clutches; shaft couplings; a new "cartridge" type ball bearing and some interesting new roller, ball and babbitted bearings for heavy use; a silent chain for precision mechanisms; pivoted motor and V-belt drives; an entirely new low tension type of rubber belting; and still another variable speed transmission.

In general it may be said that, with these additional de-

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belt itself, and about 50 per cent more strength than a rubber belt with the best type of mechanical fastener.

The vulcanizer may be plugged into an ordinary electrical circuit, and is equipped with automatic thermostat controls to maintain the proper vulcanizing temperature. Heat is uniformly distributed over the entire area to be treated, and when the two platens are clamped together a pressure of 100 lb. or more per sq. in. is maintained over the belt surface at the splice. Goodrich belts designed to be used in this way are made with rubber so compounded that successive cures at correct

- ★ Smooth Acceleration and Deceleration
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FIG. 24—Manhattan Rubber Conductor

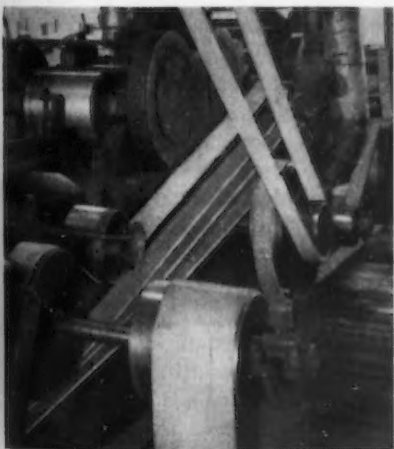
## ments to Be Described

velopments, Mr. Juraschek's review indicates first, a heightened appreciation on the part of equipment manufacturers of the great revival of interest among industrial executives in matters pertaining to better applications of power to machinery; second, a genuine effort by such equipment manufacturers to produce more efficient power transmission devices; and third, a marked tendency in all quarters to consider more carefully than ever before the economic aspects of the whole power transmission question, particularly as they apply to the reduction of present production costs. The new year promises a healthy increase in interest in this important subject.

*The Editors.*

temperature in splicing do not destroy the life and resilience of the rubber.

The ease with which a large rubber belt may be made endless directly on the job is shown in Fig. 23. Here a 22 in. 6-ply belt was joined on a drive running from a gas engine with a 5 ft. 6 in. pulley, under an idler pulley 2 ft. 6 in. in diameter to a compressor drive pulley of 8 ft. diameter. Belt speed was 4060 ft. per min. The entire belt installation took 4 hr. to complete, and has now been in continuous service for more than a year with neither belt nor splice showing any appreciable signs of wear.

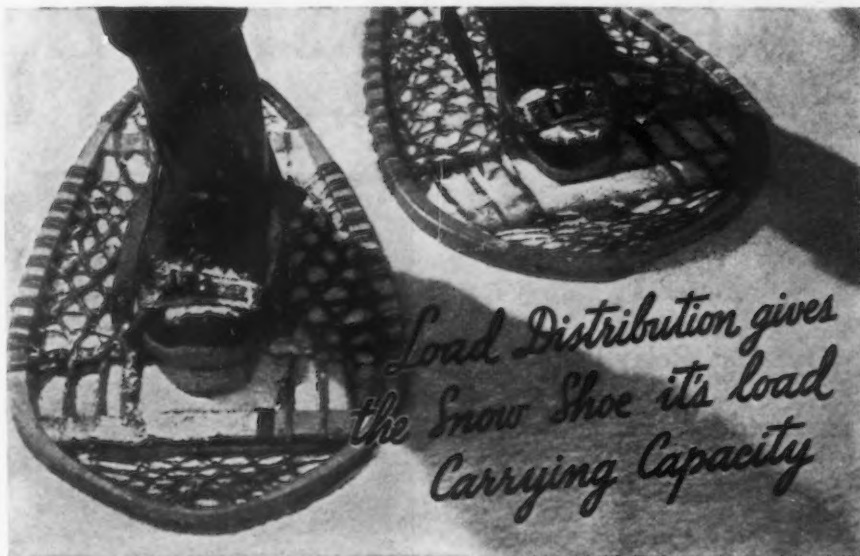


Whipcord belts on a planer installation.

It is probable that this new method of splicing will pave the way for a much more extensive use of flat rubber belting on industrial power transmission drives, for with the great improvements which have been effected in rubber belt design and construction during recent years, rubber is fast assuming a position of equal importance with the best of leather belting for transmission purposes.

A single example of recent rub-

ber belting development will be sufficient here to indicate this trend. Condor endless Whipcord belt contains an endless wound whipcord section placed in the neutral axis area, surrounded first by a layer of heat dissipating tie gum, then by a rubber cushion, and finally by the usual rubberized duck. Advantages claimed for this construction include low inelastic stretch, high degree of bending flexibility, no ply separation, no



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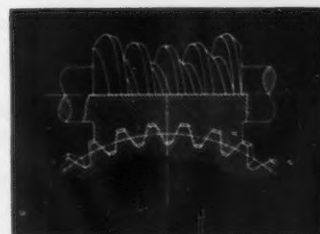
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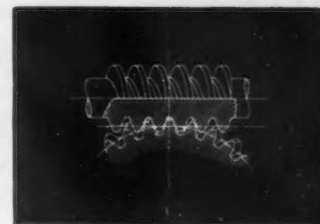
Forty million miles in 3000 cars without a single failure or replacement due to wear—continuous operation at 30,000 R. P. M.—intermittent extreme load operation at four revolutions per hour—are examples of standard conditions under which Cone Worm Gearing is operating. The whole secret of the success of Cone Gearing lies in the novel and exclusive manufacturing process which has placed it on a production basis.

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splice in load-carrying section, length consistently maintained under all conditions, and great length of life in service. As manufactured by the Manhattan Rubber Mfg. division of Raybestos-Manhattan, Inc., this new belt is now available in single light whipcord to double whipcord types, and has been found particularly efficient on short-center drives. A typical installation of these belts is shown

in Fig. 24, in use on a planer in a lumber mill.

The intensive educational work on the subject of improved power transmission methods which has been carried on in the United States in recent years by manufacturers of both electrical and mechanical power transmission equipment, by the power engineer of public utilities selling electricity to manufacturers, and by the indus-

trial press, has resulted in a degree of interest on the part of the average industrial executive somewhat difficult to realize by anyone to whom industrial conditions in the period just prior to the depression seemed to indicate the normal trend of thinking. In those halcyon days, when money flowed freely and sales managers established higher quotas of sales every year as a matter of course, the great cry was "production at any cost." It mattered little then that the power used in producing goods was not used efficiently—so long as the goods were produced which the market demanded, most executives in charge of production were satisfied.

With depression days, however, falling prices demanded economies all along the line. And, for the first time in many years, attention was again directed to the elimination of the avoidable wastes of production. It was natural, therefore, that those who preached a more efficient and more economical use of power should be heard and heeded.

Fortunately, the line of attack was clear and simple. It cost little, in terms of executive attention, once the importance of conserving all possible profits was made manifest, to preach this fundamental principle: The cost of power delivered to the work is composed of *two* items; the cost of operating the power plant (or of purchasing the power from an outside source), *plus* the cost of getting that power to the machines. Numerous analyses showed that the latter item was frequently two or more times the total of the former. And the second item had a remarkable faculty for being forgotten, or of being taken for granted as a necessary evil in its existing form.

The first real impetus to this educational effort was furnished by a small group of power transmission equipment manufacturers who cooperatively undertook a series of exhaustive engineering investigations made by the case study method in typical American industrial plants. When these reports were published, the findings stimulated enormously the study of conditions in thousands of other plants, both by the engineers employed in those plants, and by consulting engineers and technically trained equipment salesmen brought in for the purpose. As a result, it may be definitely claimed today that wherever the work of modernizing exist-

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ing transmission drive conditions is being carried out, and wherever new industrial plants are being built, a most commendable degree of attention is being paid to the economic principles of efficient power use by the men who eventually pay the bills.

There are three signs which indicate clearly the present trend of industrial power transmission thinking. The first is the attitude of the public utilities, which furnish a major part of the power used for manufacturing purposes. Very little new generating capacity has been installed in the central stations of the country since 1929, yet the past year has seen such an amazing growth in the use of electricity that all records for consumption have been broken over and over again during the past few months. As a result, the utilities are today facing the problem of spreading their present capacity to accommodate ever increasing demands. Until such time as a vast amount of additional generating capacity can be installed in the central stations, the utilities must search out every possible means of making present capacity do—and one of the most obvious ways of making it do is to show their industrial customers how to eliminate inefficient methods of applying power to their machines. And the utilities are entering whole-heartedly into this educational campaign, not for philanthropic reasons, but solely as a means of preserving their existence against the encroachments of the manufacturer of industrial power units for installation directly in the manufacturing plant.

The second sign of interest appears in the new catalogues of manufacturers of industrial power transmission equipment. Even casual inspections of these catalogues shows that items which have been shown for years with little or no changes have been redesigned to meet modern demands, and that new items are constantly appearing. In other words, research and engineering efforts are being devoted to improving the equipment of power transmission, as well as the fundamental methods. As a result, a line which hundreds of mill supply distributors five years ago were beginning to throw out as "dead merchandise" has become so profitable that these same distributors today are training special salesmen in the technical funda-

mentals of power transmission in order that they may more successfully serve their customers.

The third sign of interest appears in the industrial press. Business paper editors are a canny lot. Mere propaganda gets short shrift at their hands. They keep their fingers constantly on the pulse of "reader interest," and write and buy articles which they know will meet that interest. What, then, has caused such a shift in editorial

strategy that, in the space of five or six years, this subject of industrial power transmission has leaped from next to no space at all, to well over a thousand pages in 1936? There is only one possible answer; readers are asking questions. They want to know. The interest is there; it must be recognized and stimulated. And the editors of the industrial press are doing their best to serve the demand. (TO BE CONTINUED)

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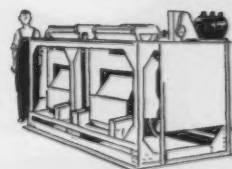
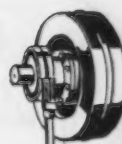
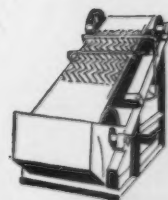
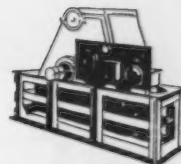
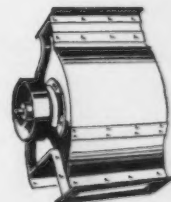
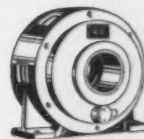
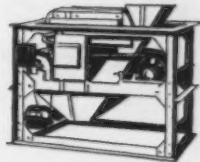
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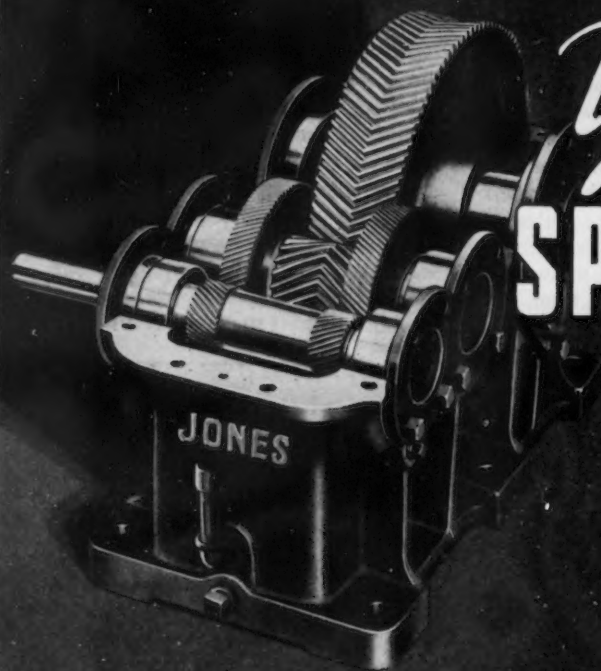
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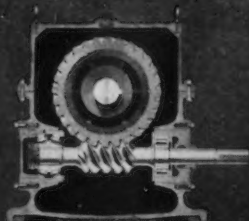
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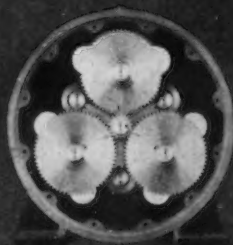
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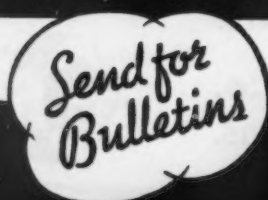
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# MATERIALS HANDLING

---

*The year's progress has been marked by improvements in equipment rather than changes in methods of handling.*

---



IT is not altogether strange that recent developments in the materials handling art should have been along the lines of technological improvements rather than along the lines of new methods, for the organization of various types of systems of materials handling had reached a high state of theoretical excellence back in the days of "Coolidge Prosperity." During that period industrial management took to heart the motion economy principles preached by that school of investigators whose fetich was time-motion study, and whose contributions to industrial efficiency coincided with an increasing lack of available human muscle-power to perform the burdensome tasks of the handling of materials.

That is the period in which conveyor systems and overhead tram-rail systems were brought to a high degree of flexibility to meet the first demands of the continuous-flow-of-production principle, and industrial trucks were developed to meet hundreds of miscellaneous demands for special service. As a result, while we find many and varied improvements in the art as compared with pre-depression days, these improvements are in equipment and not in broad theoretical principles or methods. This statement should be qualified only to the extent that there are available today many special pieces of apparatus adapted to perform jobs which in earlier days could not be fitted into a wholly mechanized materials handling system.

## Special Strip Steel Equipment

For example, as the continuous strip method of manufacturing steel began to capture the lime-

light, special types of conveyor equipment were found to be necessary to make the economical advantages of this procedure feasible. Strip steel in certain stages of the process of manufacture must be wound into coils, and these coils must be routed from process to process, sometimes on end and sometimes lying on their sides. The roller conveyor of trough section was available, but no adequate means had been developed for turning the heavy coils from the side position in which they were borne by these conveyors to the end position required for other operations.

Fig. 1 illustrates a special coil up-ender (the largest built to date) made by Mathews Conveyor Co., capable of handling coils of strip steel up to 25,000 lb. in weight. Powered by a 10-hp. motor, with countershaft and speed reducer drive, it is installed in the conveyor system in a large rolling mill in such a way that the trough section of rollers in the up-ender becomes part of the regular trough-

section conveyor along which the coils travel on their sides, and when the device is rocked 90 deg. on its cradle, the coils are up-ended and delivered to the flat section of roller conveyors to continue their travels.

Fig. 2 is another Mathews device to effect a simple right-angled turn in the direction of travel of the coils along a trough-section conveyor. This turntable turns 12,000-lb. coils of steel 90 deg. to set them into position to enter the unwinding apparatus preparatory to the pickling operation. A 5 hp. motor turns the 7-ft. table rapidly and easily in the plant of a prominent automobile manufacturer.

Fig. 3 shows a Mathews chain driven live roller conveyor used in conjunction with a Sutton tube straightener. The steel tubing handled through this straightening device varies in size from 2 in. to 7 in. in diameter, and in length from 8 ft. to 26 ft. A variable speed of from 40 ft. to 120 ft. per min. is required to suit these various sizes of tubing. Electric switches which

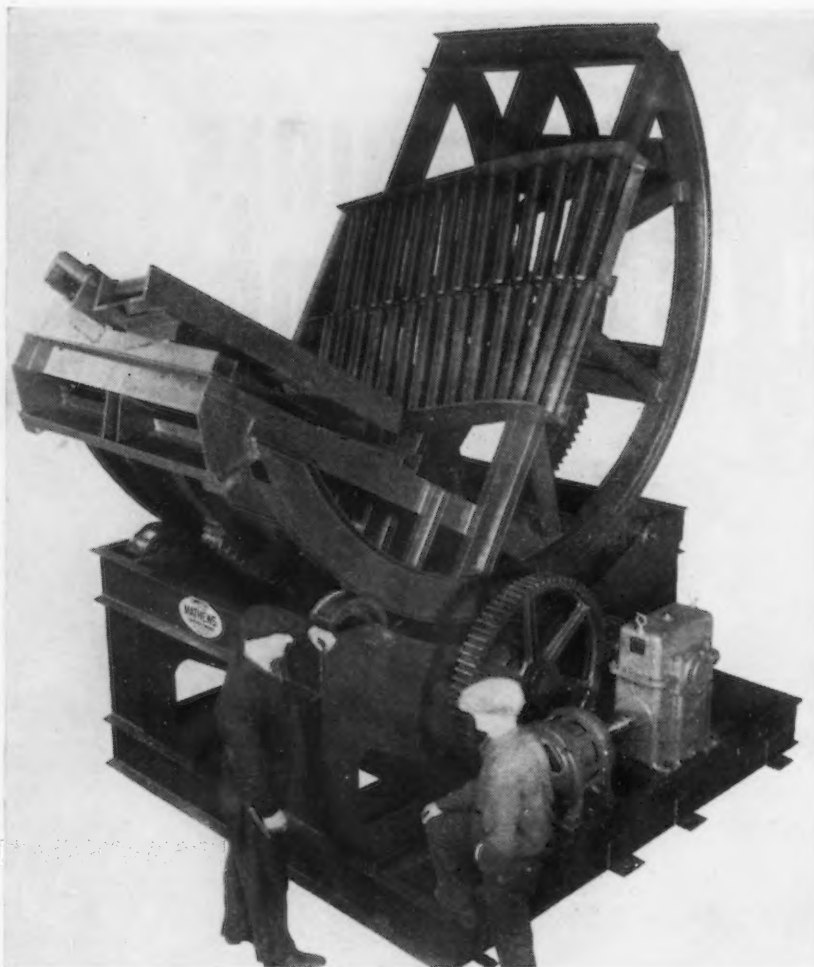


FIG. 1

**MATHEWS** coil up-ender handles 25,000 lb. coils of strip steel.

operate kick-offs remove lengths of tubing automatically from the device, at right angles to the direction of tube travel.

It is of interest to note the fact that there is a distinct trend toward a demand for high quality equipment today, as against the prevailing interest in price during most of the depression. The fact seems to have been grasped that operating costs of price-bought equipment usually offset the primary advantages of lower initial cost. This trend toward better quality equipment is seen in all the foregoing, and, taken together with an increasing demand for more automatic features of control, leads to the thought that next year will witness more serious attempts on the part of equipment manufacturers to design and build even better mechanisms than have been produced this year.

One such piece of equipment has just been made available by the

Standard Conveyor Co., Inc., and is illustrated in Fig. 4. It is a new, full-powered radial switch for use with roller conveyors. This device permits the intermediate discharge from a conveyor of many commodities the nature of which prevents their being diverted from power belt or slat conveyors because of their weight, or the construction of the carrying surface. The usual flexible switch consists merely of gravity rollers, but it is obvious that in a conveyor where several discharges are required the use of gravity switches would result in the main conveyor being a series of up and down sections. With the new Standard radial switch, a power conveyor can be set horizontal throughout its entire distance of travel and still permit discharge at any desired point. The rollers, instead of being of the gravity type, are power driven, and an ingenious arrangement makes possible the application of power to all rollers regardless of the position of the switch. That is, the rollers are positively driven whether the switch is in a position for straight ahead travel, or in a position for discharge to a lateral line.

The switch is moved to its various positions by power, and, after the operator presses the button, it is entirely automatic in operation. The switch stops when it reaches

(CONTINUED ON PAGE 452)

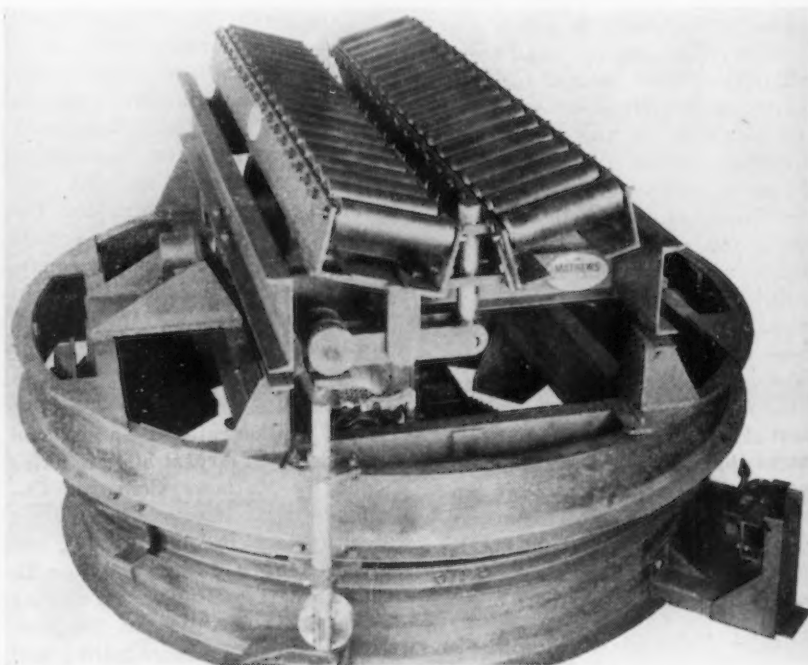


FIG. 2

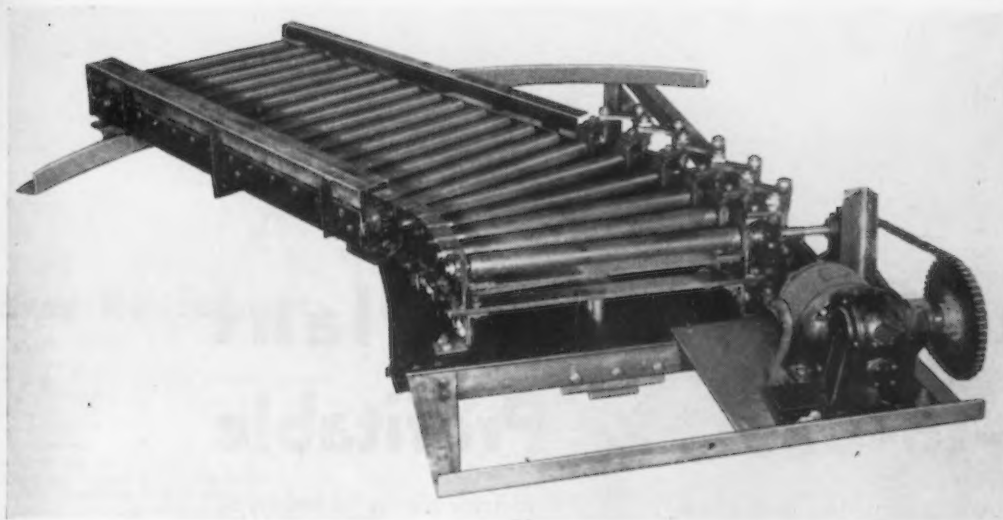
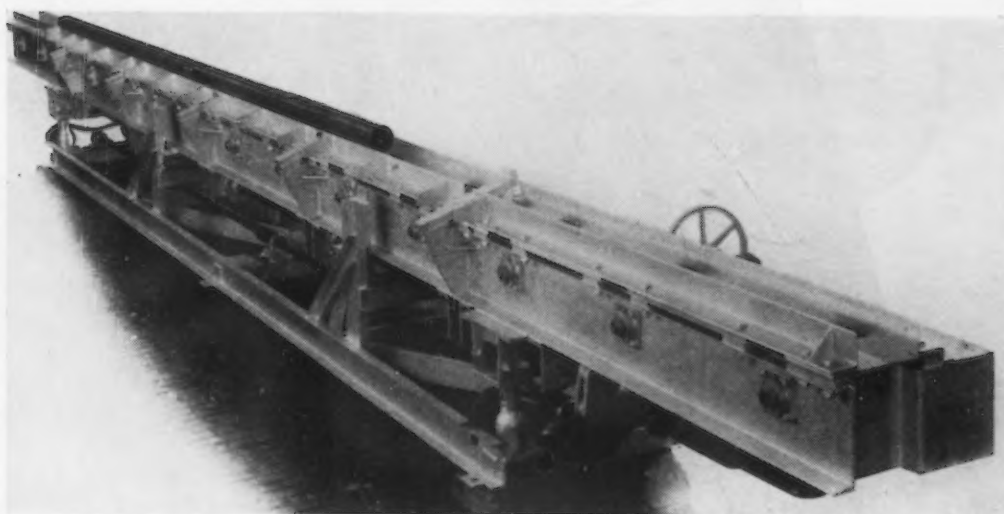
**MATHEWS** power turntable for handling strip steel in coils.

o o o

FIG. 3

**C**OMBINATION  
tube straighten-  
er and live con-  
veyor with automatic  
kick-offs.

o o o



o o o

FIG. 4

**S**TANDARD CON-  
VEYOR CO.  
automatic power-  
operated radial  
switch.

o o o

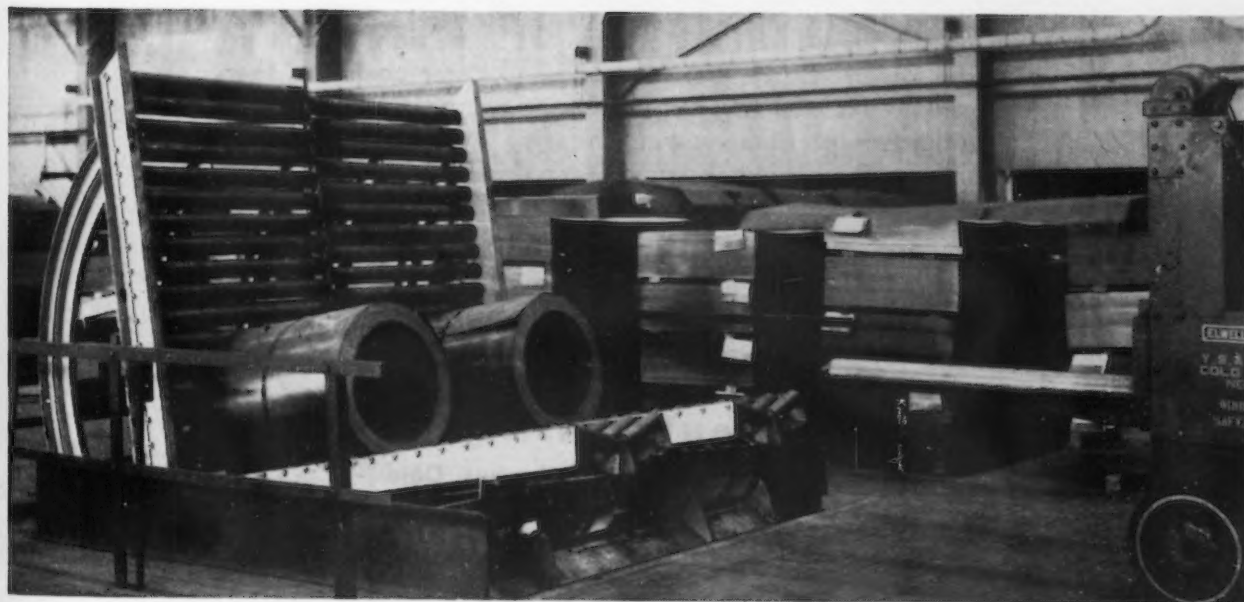


FIG. 5

o o o

**E**LWELL-PARKER ram truck delivering strip steel coils to Mathews up-ender.

o o o



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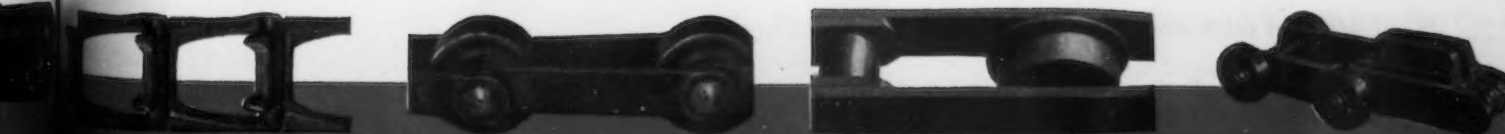
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## Materials Handling

(CONTINUED ON PAGE 456)

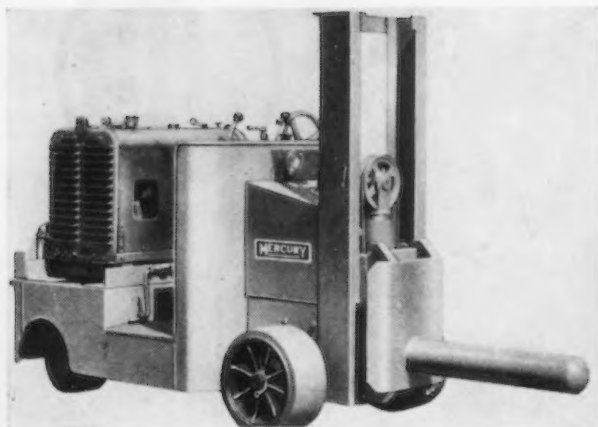


FIG. 6

**N**EW Mercury ram truck for transporting coils of strip steel.

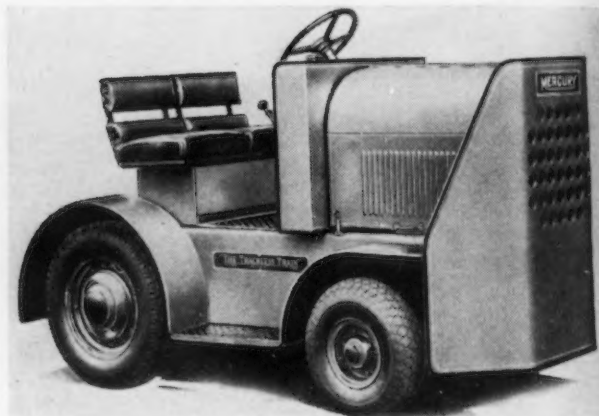


FIG. 7

**M**ERCURY tractor with Ford 4-cylinder industrial engine as power plant.

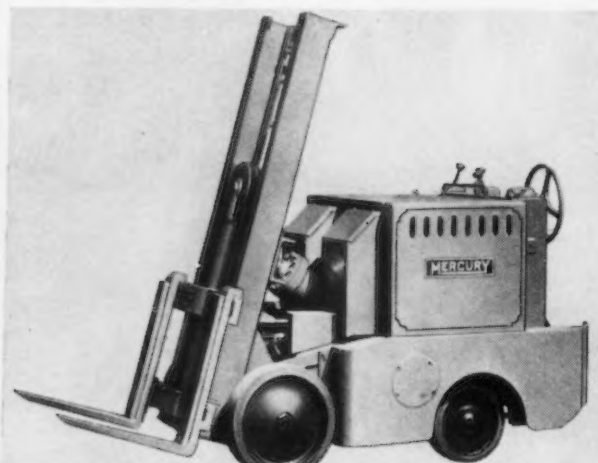


FIG. 8

**M**ERCURY tilting, tiering fork truck to carry loads of 4000 lb.



FIG. 9

**A**UTOMATIC Transportation elevating platform storage-battery truck.



FIG. 10

**N**EW streamlined elevating platform truck made by Baker-Raulang.



FIG. 11

**A**N industrial trailer which is completely spring-suspended.

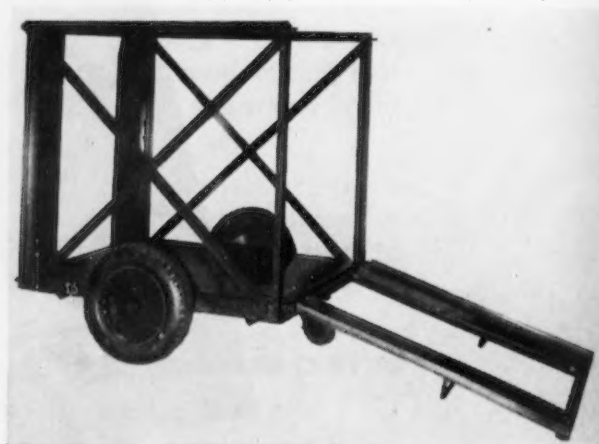


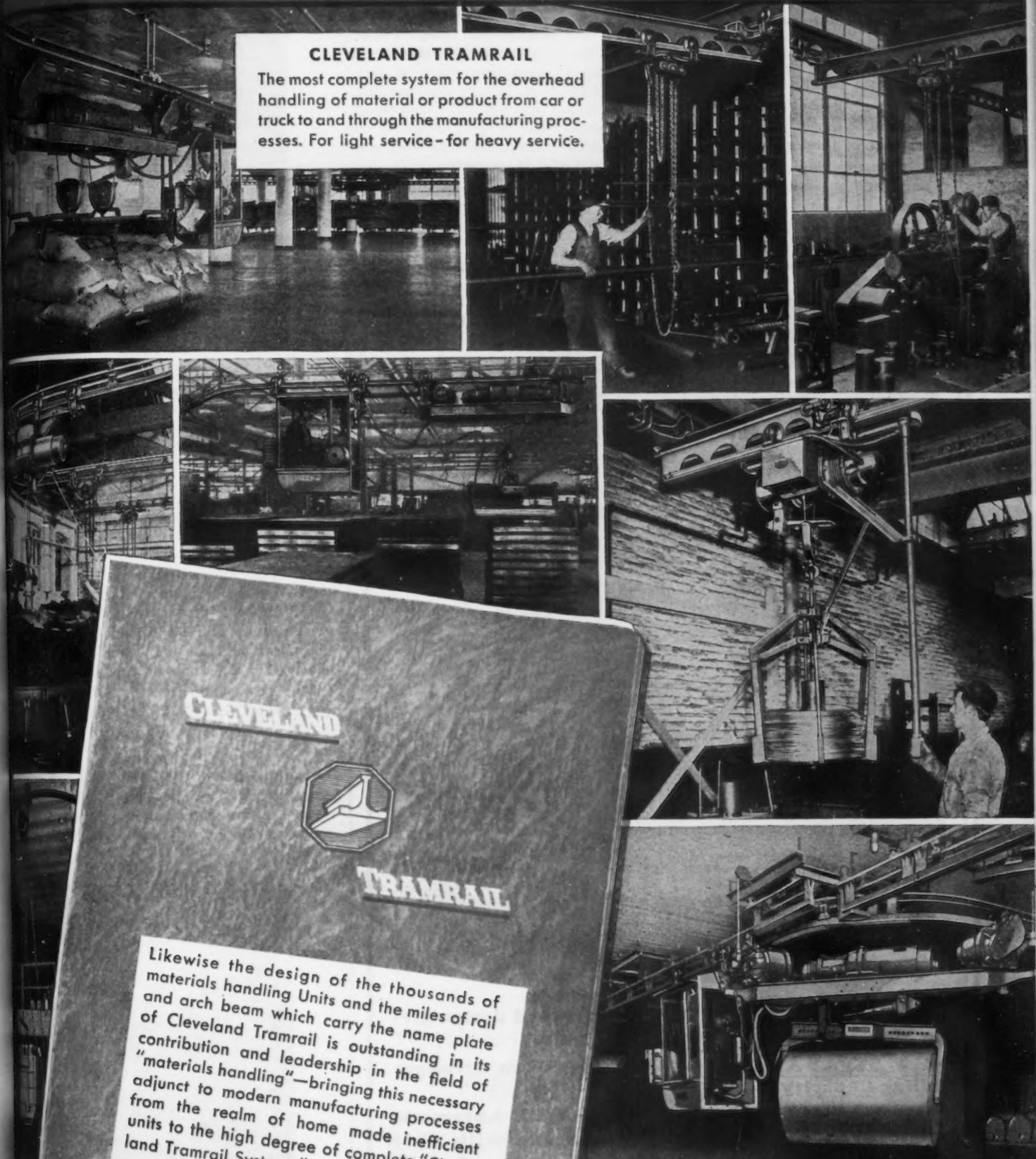
FIG. 12

**T**HE "outside" truck of the Service Caster "outdoor-indoor" truck combination.

# HANDLING EQUIPMENT

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(CONTINUED FROM PAGE 452)

the discharge position and after the commodity has passed over it, returns to normal position without further attention. This device is available in different types for heavy or light commodities, from 500 to 600 lb. of tote pans, drums or coils to the lightest cartons.

Of particular interest in strip steel mill operation is the truck in

illustration Fig. 5. A special ram-equipped Elwell-Parker Electric Co. electric industrial truck picks up coils of strip steel from the floor on the ram and carries them to a Mathews up-ender, which in turn delivers them in a vertical position to a flat section roller conveyor. The ram will lift coils weighing up to 6000 lb. from the floor level to a height of 5 ft., if required.

Mercury Mfg. Co. has also de-



Special 65" Ohio Magnet lifting wide coil of Strip Steel VERTICALLY.

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FIG. 13

**LEWIS-SHEPARD** hand-operated tier

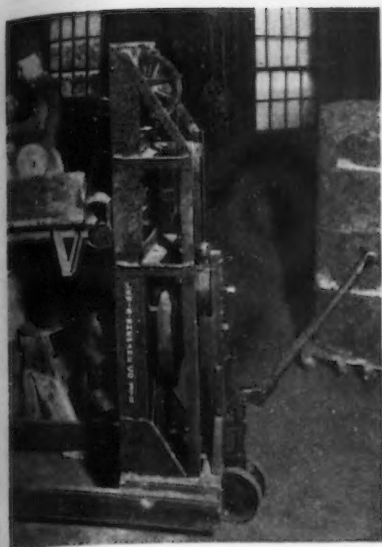
veloped a new heavy-duty center control ram truck for this service, as shown in Fig. 6. This truck is of the front wheel, 2-wheel drive, and rear wheel, 2-wheel steer type. It is equipped for gas-electric power, or storage battery operation. The ram rises from a height of 18 in. to 60 in. above the floor level, and will lift and carry coils weighing up to 7000 lb. and 36 in. in length. The ram is hydraulically elevated. A feature of this truck is the new center control, affording unusual accessibility of control, flexibility of operation and full vision of the load at all times.

The new "Huskie" Mercury tractor shown in Fig. 7 is a 4-wheel, 4-cylinder Ford engine tractor with double reduction drive axle and 4-



FIG. 14

**HAND-LIFT** trucks with skid platform



ing truck adapted to foundry work.

speed truck type transmission. It is available with either solid or pneumatic rubber tires. The light running speed is 10 miles an hour and the maximum draw-bar pull is 3000 lb. in low gear at 1 1/4 miles an hour.

A new Mercury tilting, tiering fork truck is illustrated in Fig. 8, especially adapted to the handling of tin plate. The capacity is 4000 lb. with 16 in. length of load. As shown the truck is storage battery operated, but a gas-electric unit is also available. The forks rise to a height of 52 in. above floor level, and have a forward tilt of 5 deg. and a backward tilt of 15 deg. Telescopic uprights can be furnished which enable the forks to rise to an increased height while the same



bins reduce rehandling operations.

overall height of the truck is maintained. Fork elevation and tilting of uprights is accomplished hydraulically, and the hoist and tilt motor circuit is controlled by a magnetic contactor control actuated by a lever-operated push button. Control of truck travel is by means of magnetic contactor type controller, with three speeds forward and reverse.

An Automatic Transportation Co. 5-ton lift-platform truck is shown

in Fig. 9 transporting a typical load of material in a skid totebox from one building to another. These storage-battery trucks are typical of recent advances made by many equipment manufacturers in the better known types of industrial carriers.

A new line of gasoline engine-powered elevating platform trucks in capacities of 3, 4 and 5 tons, as shown in Fig. 10, has just been announced by the Baker-Raulang

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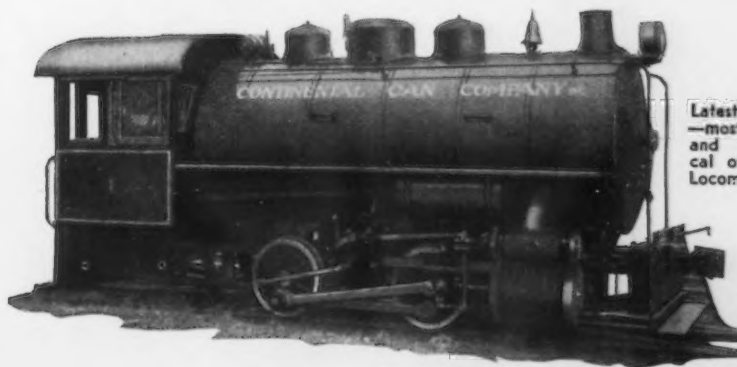
in a big steel plant (*not* Continental Can) by replacing a 40-ton saddle tank engine with a 40-ton Heisler Fireless.

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## by using the Most Efficient Fireless built—the HEISLER

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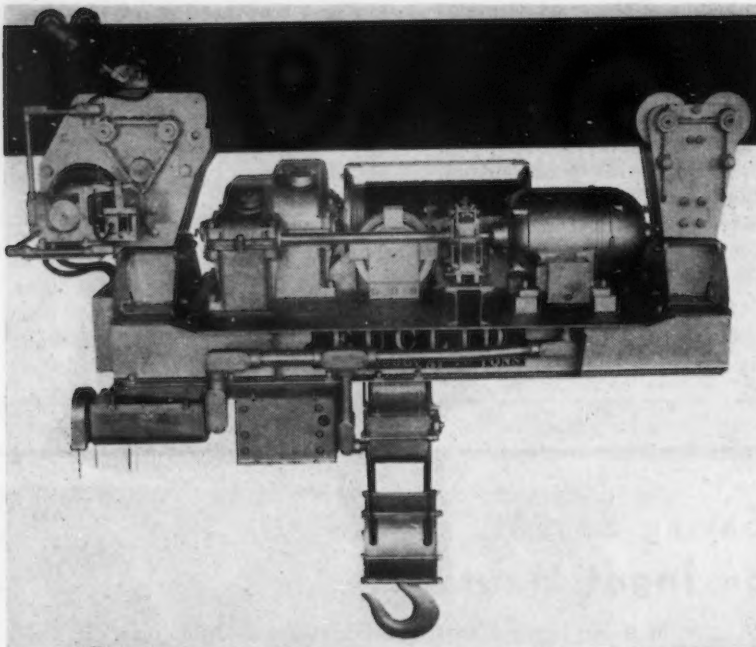
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Co. They reflect the modern trend toward streamlined design, with all units completely housed in rounded inclosures. Major units, such as the power axle, frame, etc., are largely interchangeable with the corresponding units in the Baker-Raulang electric trucks. A Hercules type IXB engine is used, developing 46.5 hp. at 3200 r.p.m. The elevating system is hydraulic, with the pump driven from the engine crankshaft by a triple V-belt. All controls are conveniently located, with the gear shift and elevating control levers at the driver's right on top of the dash, and the

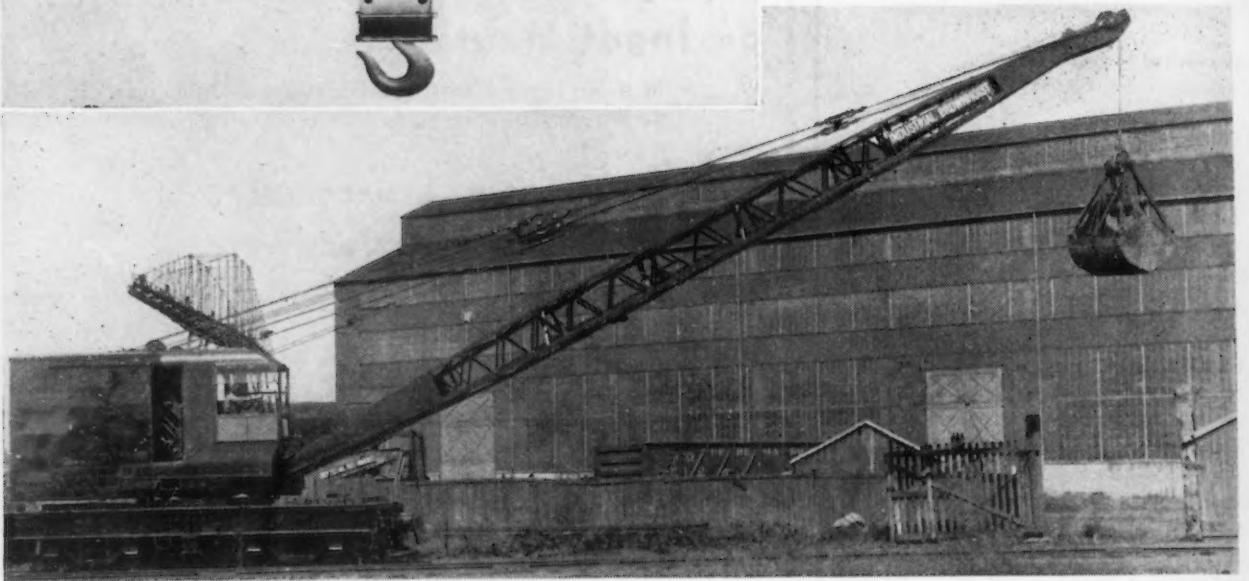


FIG. 15—Upper LEFT

**W**ELEDGED steel construction is a feature of this new Euclid electric hoist.

o o o

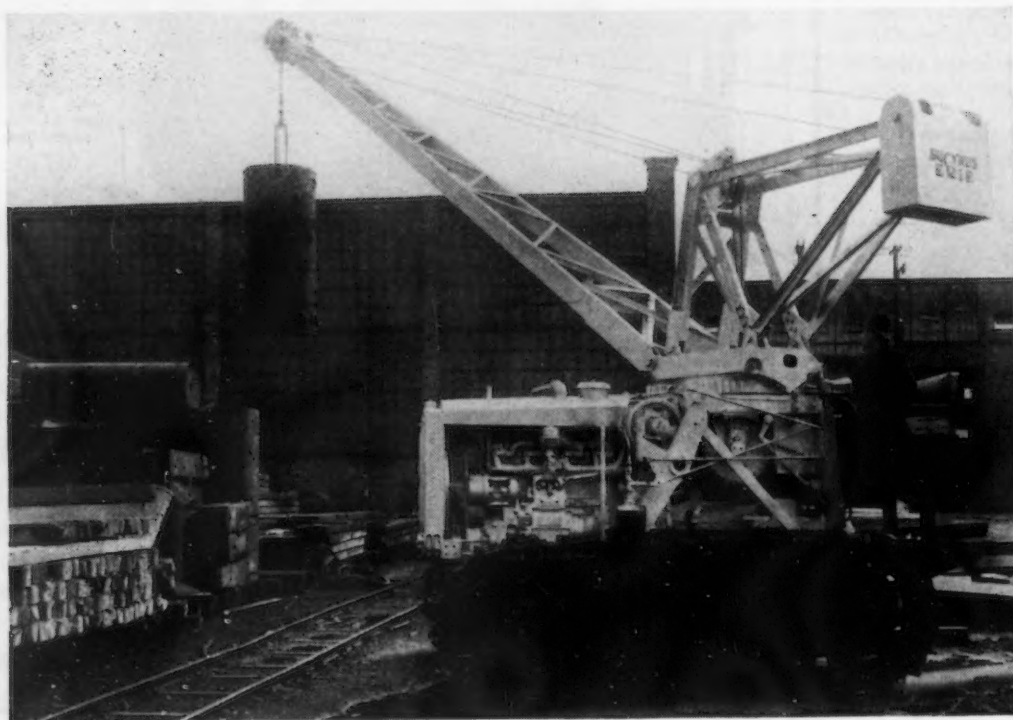
FIG. 16—CENTER

**N**EW Brownhoist diesel locomotive crane for heavy industrial service.

o o o

FIG. 17—AT LEFT

**B**UCYRUS-ERIE 10-ton crawler-type gasoline engine utility crane.



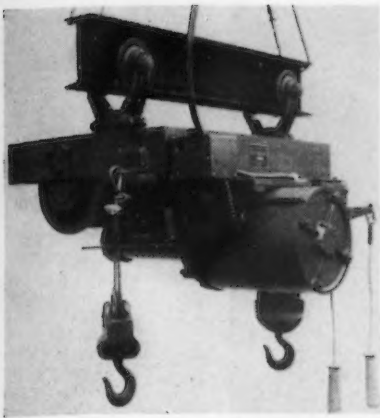


FIG. 18

**E**LECTRO-LIFT'S new twin-hook high-speed electric hoist.

throttle is placed in conjunction with his steady-rest so that he can maintain complete control over the speed without relinquishing his hold on the grip. Speed of travel is governed to  $7\frac{1}{2}$  miles per hour, although a maximum speed of 10 miles per hour may be had. These

trucks will maneuver in practically the same space as corresponding electric trucks.

In this section of the review mention should be made of two new Mercury trailers. The one shown

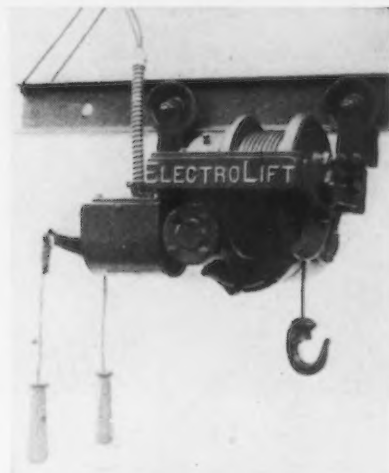


FIG. 19

**T**HIS new Electro-Lift hoist provides close headroom application.

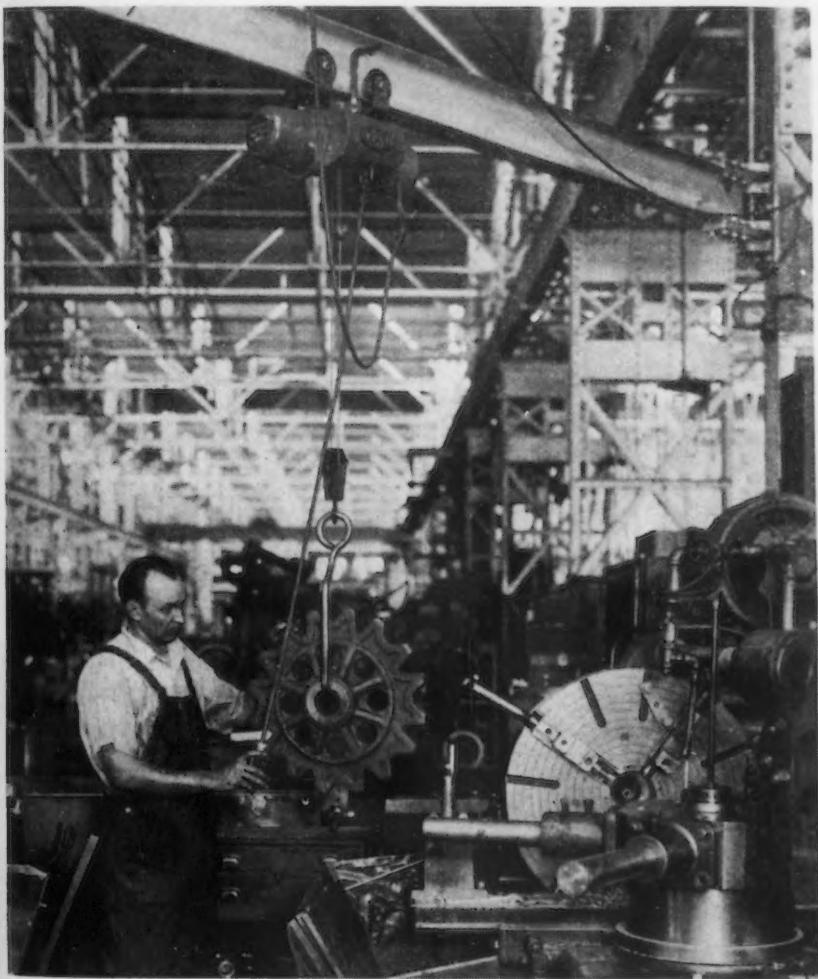


FIG. 20

**T**HE Zip-Lift electric hoist facilitates spotting of work at machines.

in Fig. 11 is unique in being fully spring-suspended. The deck is 60 in. by 108 in., and is  $26\frac{1}{2}$  in. high when unloaded. Another type of trailer, without a deck, is designed especially for a manufacturer of automobiles to carry steel skid boxes. The skids are handled by a special elevating platform truck and deposited on the trailers to fit over the bolster plates fastened to the side members of the frame.

The Service Caster & Truck Co. has developed a unique "indoor-

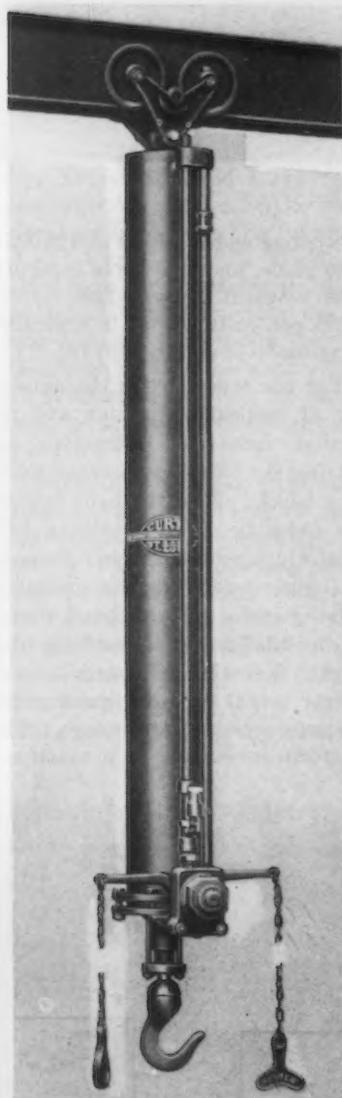


FIG. 21

**C**URTIS pendent air-hoist, mounted on trolley, handles parts rapidly.

outdoor" truck combination. The outdoor truck, shown in Fig. 12, has one end of the frame so constructed that it can be let down to form a skid. The indoor truck, loaded, is run up this skid on to the platform of the outdoor truck,

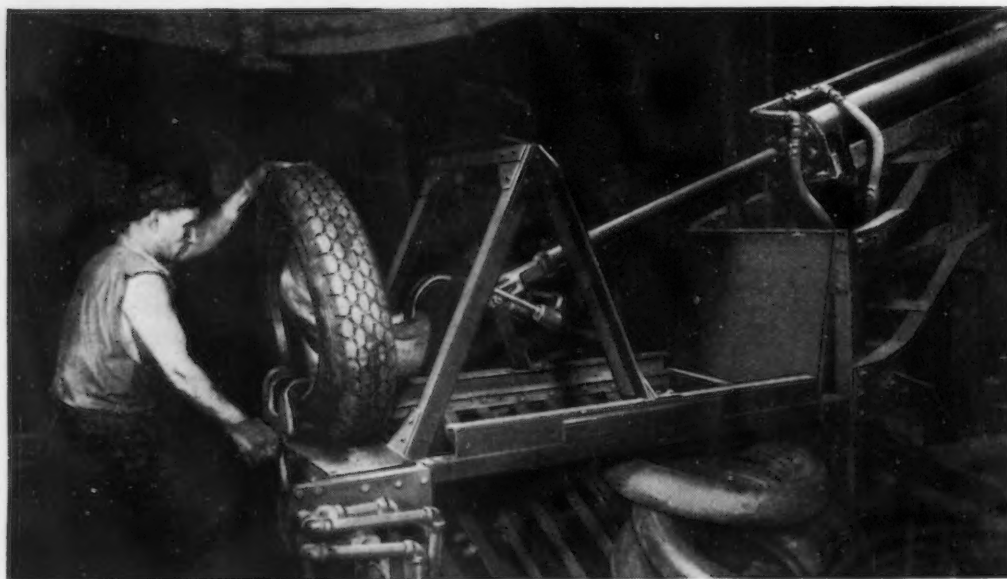


FIG. 22  
THE Curtis air-hoist  
in a special tire  
manufacturing adap-  
tation.

the frame end lifted up and latched into place, and the whole combination wheeled away. This duplex truck can be furnished in capacities ranging from 500 to 5000 lb.

For use especially in the annealing of malleable castings and for similar industrial operations requiring the handling of small parts to a height above the floor beyond the capacity of the ordinary lift-platform truck, the Lewis-Shepard Co. has developed the portable, hand-operated elevator truck shown in Fig. 13. The truck platform lifts a skid box load of parts to the proper height for easy, quick packing into pots, or for storage. The platform is elevated by a winch ar-

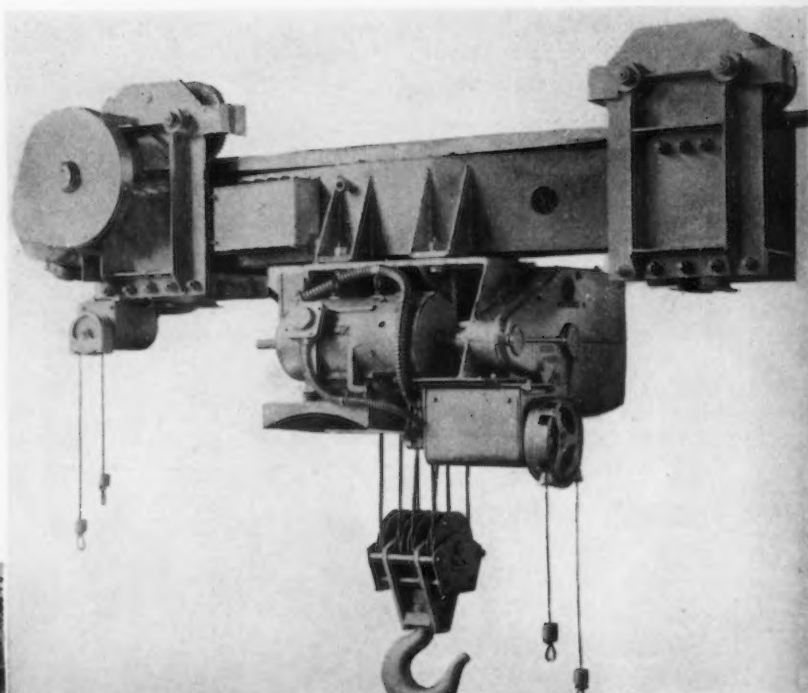


FIG. 22A—ABOVE  
ROBBINS & MYERS  
10-ton electric  
hoist with welded  
steel double swivel  
trucks.

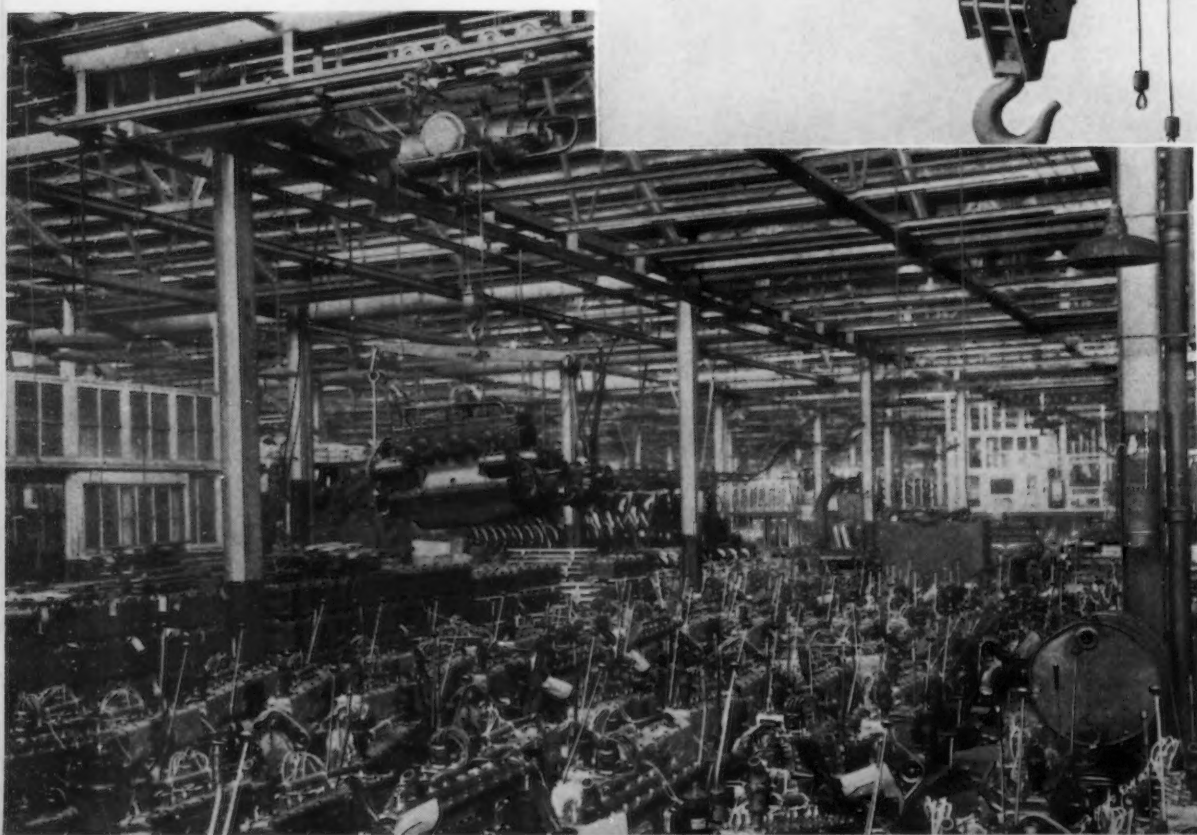
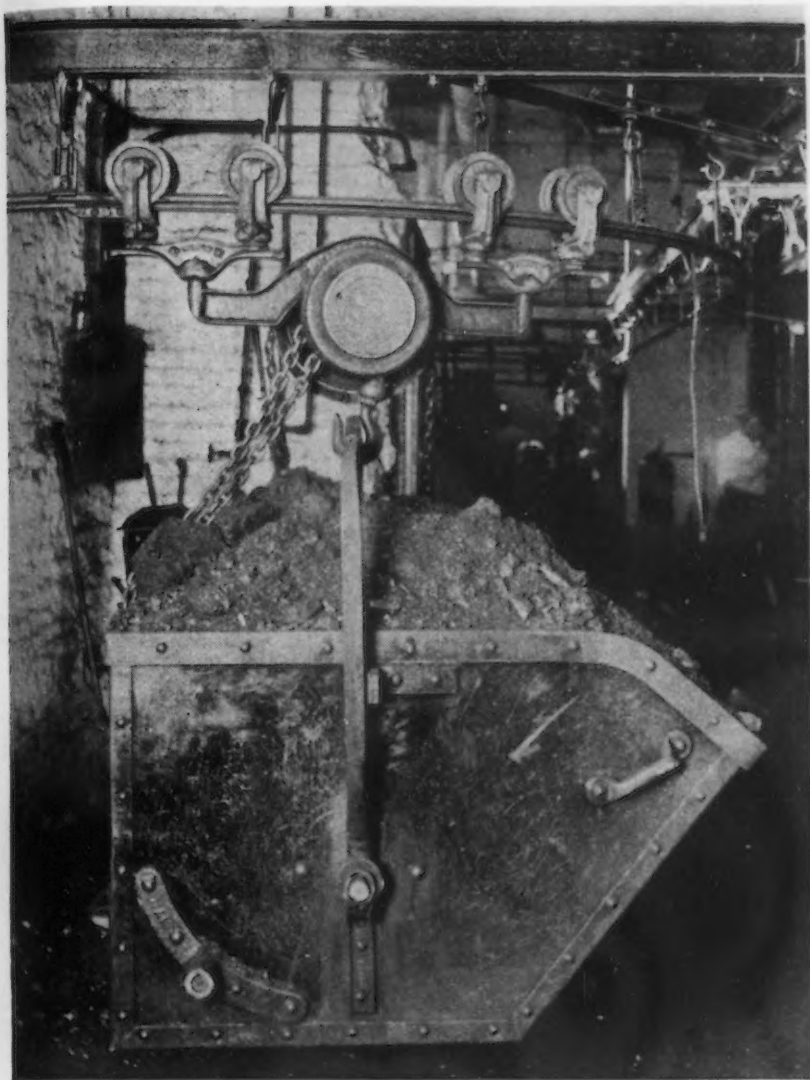


FIG. 23  
OVERHEAD tram-  
rail systems re-  
cover the "forgotten  
half" of the factory.



**FIG. 24**  
**LOUDEN** single point suspension bucket carried on monorail track.

bearing boxes welded into place. The main frame on which the hoisting mechanism rests is all of steel plate welded into a box-like structure.

Units of this type of construction have been installed at the Middletown Air Depot, Middletown, Pa., the complete installation consisting of two 10-ton 3-motor cranes, one 5-ton 3-motor crane, one 3-ton crane, six 10-ton monorail hoists, three 1-ton electric hoists, one 2-ton electric hoist and twenty 3-ton monorail trolleys.

Industrial Brownhoist Corp. has added to its extensive line an 8-wheel 40 to 50-ton diesel locomotive crane as shown in Fig. 16, which is especially adapted for use in steel mills and in industrial plants where heavy lifts and large tonnages must be handled. It is economical to operate, starts quickly and is suitable for all kinds of bucket, hook and magnet service. It contains a 2-speed hoisting mechanism and has four travel speeds, with a high of 15 miles an hr. The crab is disengaged when the crane is used as a locomotive for switching service.

Bucyrus-Erie Co. has put out a crawler-type gasoline engine propelled crane of 10-ton capacity, as shown in Fig. 17 which has practically no limitations for industrial yard service. Like the Army tank, this device will go anywhere and do anything within the range of its lifting capacity.

The new Twin-Hook Monorail

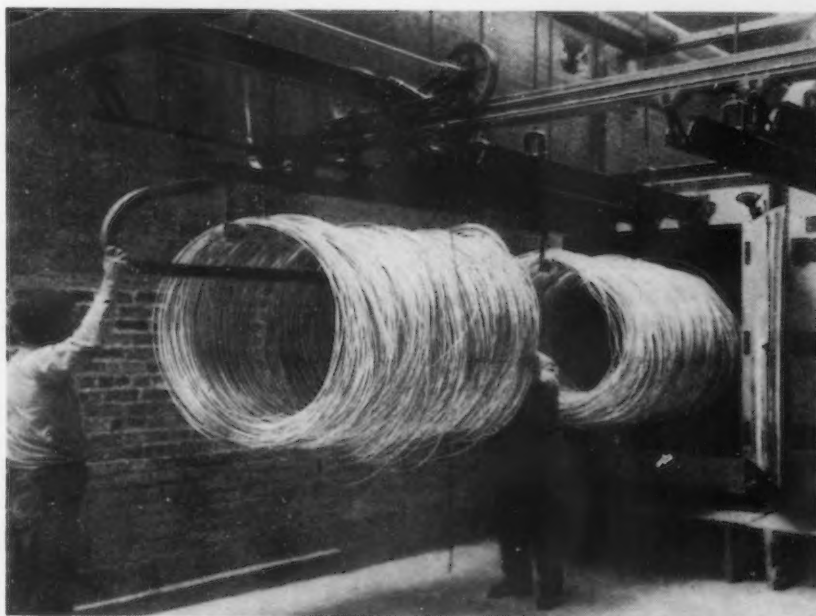
arrangement whereby the cable reel is wound up by a hand-crank.

Fig. 14 shows the new Lewis-Shepard hand lift trucks with skid platform bins handling iron and steel parts and scrap in a wire and steel mill. Note that all material is off the floor and ready to be moved around without further picking up or rehandling.

#### Cranes and Hoists

Euclid Crane & Hoist Co. has recently developed the use of welded steel construction to a remarkable point in its new electric hoists. Fig. 15 shows a 10-ton floor operated monorail hoist of this new type.

Both the driving trolley and the idle trolley are of welded steel plate (except for the trolley wheels), heavily ribbed and with



**FIG. 25**  
**A SPECIAL** Louden arrangement for handling coils of wire at ovens.

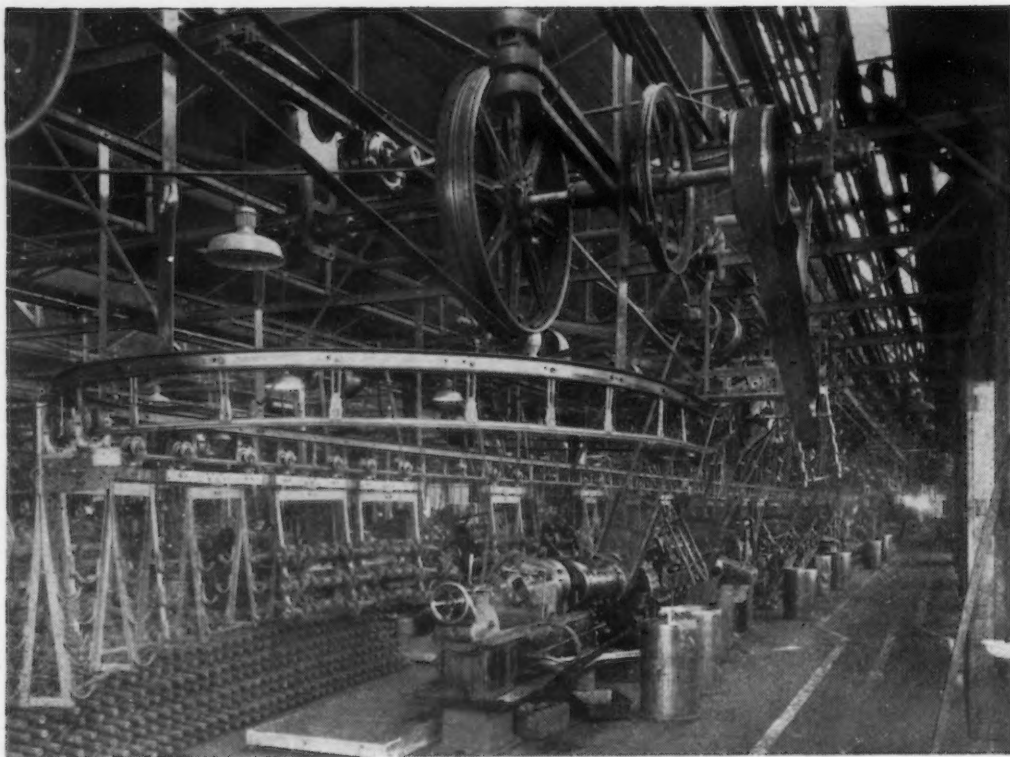


FIG. 26—AT LEFT  
**L**ouden carriers  
serve 400 ft. of  
progressive machin-  
ing operations.

o o o

FIG. 27—BELOW  
**T**he new C-M car-  
puller serves a  
thousand special  
plant needs.

electric hoist built by Electro-Lift, Inc., is illustrated in Fig. 18. It is built in capacities from  $\frac{1}{4}$  to 3 tons, and is designed for use wherever long or bulky loads are to be handled. Such loads, lifted from two points, are carried on two drums spaced to meet the lifting requirements, operated from a sin-

gle shaft by the worm-gear hoist unit, and all carried on a compact, rigid welded steel frame. Control may be either pull-rope type, or push-button type.

Another Electro-Lift development is a new high-speed close headroom junior type electric hoist, illustrated in Fig. 19, with a hoist-



**ONE SHOT  
and it's  
Lubricated**

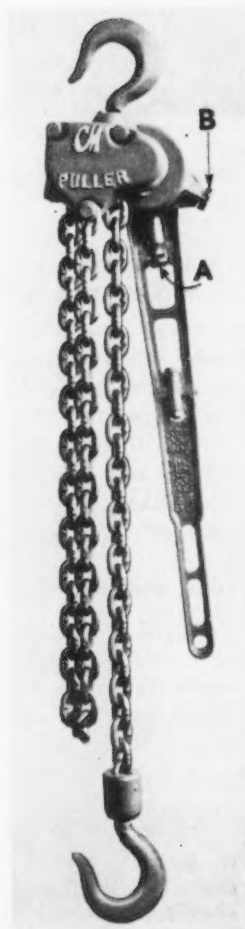


The lubrication of a Robins Conveyor Idler is simplicity itself . . . just one grease fitting conveniently and safely located at each end of the idler . . . just one shot in either fitting and the job is done. No danger to life or limb. No danger of over-greasing. This patented lubricating system is only one of the exclusively Robins features that are the reasons why Robins Conveyor Idlers last longer and cost less to operate.

**ROBINS**  
MATERIAL HANDLING  
EQUIPMENT

**ROBINS CONVEYING BELT CO.**  
15 PARK ROW, NEW YORK, N. Y.  
Branches in Principal Cities

**SEND FOR DESCRIPTIVE LITERATURE**



ing speed of 60 ft. per min. and capacities of 250 lb. and 500 lb. This type is especially adapted for use in automobile plants for the rapid handling of small loads in volume production. The drive is of the worm and wheel type. Very close headroom between hook and overhead track is provided. Control may be either pull-rope or push-button type.

The Harnishfeger  $\frac{1}{2}$ -ton Zip-Lift electric hoist illustrated in Fig. 20 is typical of recent developments of many hoist manufacturers in the small electric hoist field. Mounted with a trolley on a swinging jib crane, and operated by push-button control, it facilitates the spotting of heavy work on machine tools. Control is so sensitive that the load may be "inched" into position with ease.

#### Pneumatic Equipment

The Curtis Pneumatic Machinery Co.'s pendant air hoist on a trolley, as shown in Fig. 21, provides an ideal arrangement for handling small parts in process wherever compressed air is already available in the plant. They have lifting speeds up to 65 ft. per min. in capacities from  $\frac{1}{2}$  to 10 tons. Two factors of economical advantage are claimed for the newer types; initial cost is much lower than other forms of power hoists, and maintenance costs, particularly where atmospheric dust, lint, moisture, etc., must be contended with, are very low.

A new Curtis development is the arrangement shown in Fig. 22. This picture was taken in the plant of a prominent tire manufacturer. The special claw device at the end of the air-hoist piston pulls an inner tube out of the shoe. This operation is performed every 10 sec., 24 hr. a day, five days each week. After  $1\frac{1}{4}$  million operations in seven months the only maintenance expense was for oiling and renewal of leather cups and the repacking of stuffing boxes and valves.

#### Overhead Tramrail Equipment

One of the outstanding features claimed for overhead tramrail-trolley systems is that they enable valuable floor space to be made available for manufacturing operations or storage facilities. This fact is clearly made apparent in Fig. 23, where Loudon Machinery Co. monorail equipment enables the "forgotten half" of a factory to be kept clear for other than materials handling uses. The monorail hoist

## THE KEYSTONE OF MODERN STEEL PRODUCTION

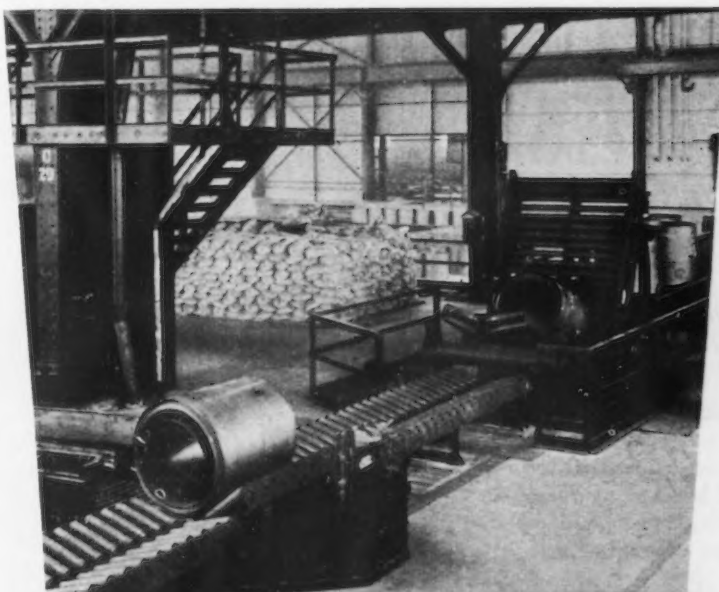
**C**ONTINUOUS is the big word of the Steel Industry today. Steel men know that long before the continuous strip mill came into the limelight the ideal of Continuous Flow production was a fixed objective of the industry, dating back to the invention of the open-hearth process.

So it is natural that Mathews Conveying Equipment, developed originally for all Industry, has for more than 30 years embodied the Continuous Flow Principle. Mathews engineers, from the very first, saw that material handling in the Steel Industry was the keystone of the production process.

Mathews Conveyers include Belt, Live Roller, Drag Chain, Roller Chain, Pallet, Continuous Apron, Wheel and Roller Conveyers. Also Vertical and Inclined Elevating Conveyers, special devices for up-ending, down-ending, tilting and transferring, for the handling of Hot and Cold Billets, Bars, Shapes, Sheets, Packs, Coiled Steel, Pipe, Tubing in continuous flow processes.

*The leaders in this industry, responsible for 85% of steel production in the United States, are applying the Continuous Flow Principle of Handling Materials with Mathews Conveyers.*

**MATHEWS CONVEYER COMPANY** 114 TENTH STREET  
ELLWOOD CITY, PENNA.



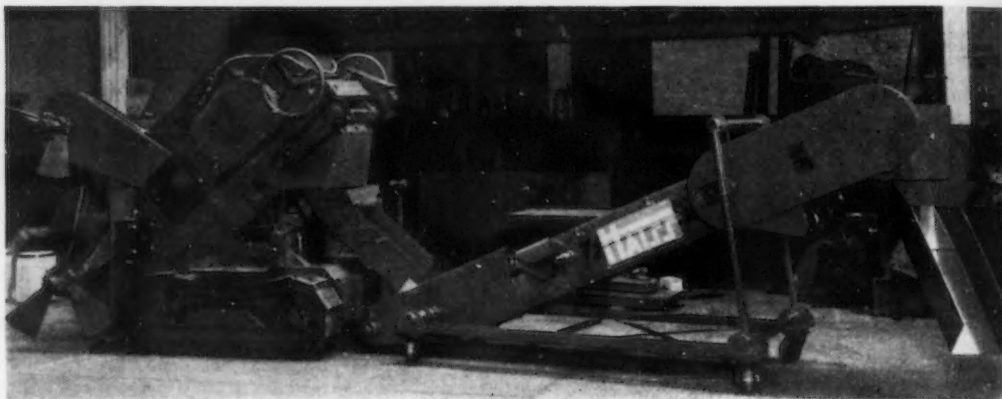
**MATHEWS**  
CONTINUOUS FLOW PRINCIPLE OF HANDLING MATERIALS  
**CONVEYERS**



FIG. 28—ABOVE  
LINK-BELT light portable belt conveyor is an ideal loading unit.

o o o

FIG. 29—AT RIGHT  
THE new Haiss box car unloader with attendant portable conveyor.



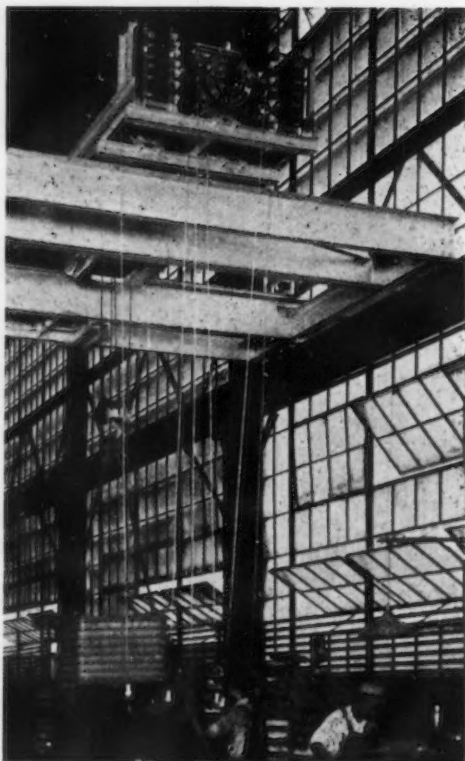
## WE MAKE CRANES

—that fit your requirements like a glove. Or, if they don't, we'll build them special!

R & M electric cranes are made in all the usual types—electric traveling cranes up to 10-ton capacity; wall-bracket, under-hung, and mast-jib types; and hand-power cranes of every kind.

"Big industry" has tested and approved the design, materials, and workmanship of this complete line. When replacing obsolete equipment, or planning new installations, be sure to consult R & M.

Write for Bulletin 5091. It is full of crane information; shows model installations, etc.



R & M 5-TON Electric Traveling Crane

# ROBBINS & MYERS

HOIST AND CRANE DIVISION

SPRINGFIELD, OHIO

picks up and carries a heavy load above the working space.

The single point suspension bucket shown in Fig. 24 suspended from a special monorail carrier marks a recent Loudon development for handling coal, ashes, sand or other bulk materials. The latch operates manually to allow the bucket to be tipped forward.

In Fig. 25 a special Loudon arrangement is shown for the rapid and easy handling of wire and steel rope into processing ovens. Special carriers hold the material on a

monorail section which is part of a carriage traveling laterally on two rails of a Loudon crane system. At proper intervals the monorail section switches the loads to similar monorail tracks entering the ovens.

In a large automotive plant rough forged shafts are handled through progressive machining operations in the leather-lined hooks of the Loudon monorail system shown in Fig. 26. With a total distance of 400 ft. to be traversed, various machining operations are completed and the shafts returned overhead by this system. The aisle to the right is kept clear at all times.

### Car Pullers

The Chisholm-Moore Hoist Corp. has designed an efficient, lightweight, folding, spur-gear car puller, operated by a ratchet handle somewhat similar to a jack. This device is shown in Fig. 27. It is used for pulling any object in a horizontal or vertical direction, or at any angle, in addition to its primary use of pulling freight cars to position. It is available in capacities from  $\frac{3}{4}$  tons to 6 tons.

### Miscellaneous

Portable conveyors are rapidly gaining favor for the intermittent



FIG. 30

**LINK-BELT'S** Speed-O-Matic control for shovel-dragline-crane equipment.

handling of bulk materials from railroad cars or storage piles. The Link-Belt Co. loader illustrated in Fig. 28 is typical of this class of equipment. Along the same line, the George Haiss Mfg. Co. has developed a box car unloader, as illustrated in Fig. 29, which combines a self-contained mechanism for picking up bulk materials and one or more portable conveyor sections. The unloader itself is designed to work inside a regulation box car, with the portable conveyor sections trailing behind it to take the material unloaded and transfer it. The outfit consists of two (or more) machines; a very small bucket loader of a size permitting it to go through the door of a box car, that is, 5 ft. wide, 7 ft. high and 9 ft. long, and one or more short belt conveyors, approximately 11 ft. long, attached to the first machine by linkage. The loader is mounted on caterpillar creepers, and is provided with two gear-head electric motors, one for traction and the other for the elevator. The maximum capacity is about 2 cu. yd. Complete operating controls and operating platforms are provided on both sides. There are two speeds of travel in both directions, one of 30 ft. per min. for moving about, and the other of 5 ft. per min. for crowding the loader into the pile. The illustration shows the loader equipped with a special upper-cut-

ting shaft and blades (not ordinarily provided) for use when handling material which has a tendency to form a crust. Any material which can be shoveled by hand without picking, which is not sticky, and which contains no lumps larger than 6 in., can be handled rapidly by this equipment.

Haiss "Coal King" flight conveyors (not illustrated) are portables of the general type shown in the Link Belt illustration. They are now built in lengths from 20 ft. to 35 ft., either electric motor or gasoline engine driven, with discharge height when set at the maximum 35 deg. inclination ranging from 8 ft. 7 in. to 17 ft. 1 in. All models are equipped with push-button control, and have high capacity troughs for maximum service.

#### Speed-o-Matic Control

Link-Belt Co. announces (see Fig. 30) a new control system for shovel-dragline-crane. This is power operated, with short, easy-throw levers, producing much speedier operation and greater output, with elimination of operator fatigue. The operator is comfortably seated at the front of the cab, and even the foot pedals are reached from this seated position. Maintenance costs, as compared with similar equipment operated by old methods, are said to be less.

Robbins & Myers, Inc., has an-

nounced two new electric hoists which include unique features. In Fig. 31 is shown a half-ton hoist with an extended rigid arm twist handle control. The load is hoisted, lowered or moved along the monorail track by means of this single handle. This novel control arrangement was developed for applications over vats, benches, kettles, etc., to give the operator the opportunity of quickly and easily making all necessary load movements while he himself remains in the clear. Such control fills many requirements of unusual service, and was designed in response to requests from numerous hoist users.

In Fig. 22A the welded steel type of construction which is becoming so popular is once more utilized in a 10-ton Robbins & Myers electric monorail hoist. The double swivel trucks, of saddle type, are built of all welded steel. King bolts are eliminated and the load is suspended in a yoke of steel plate, giving exceptional strength and rigidity with lighter weight.

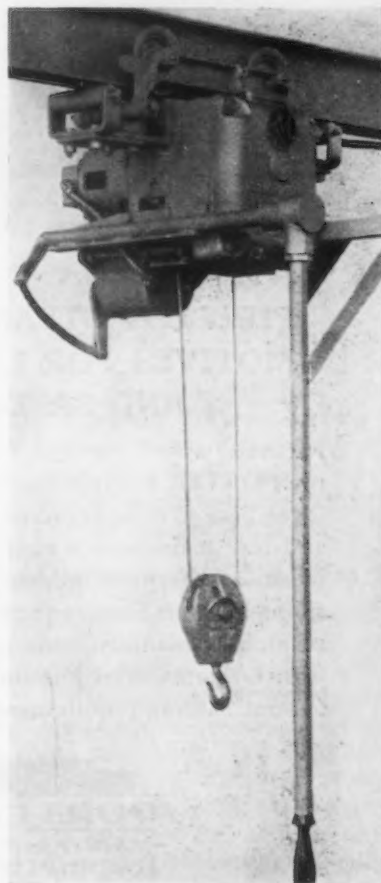
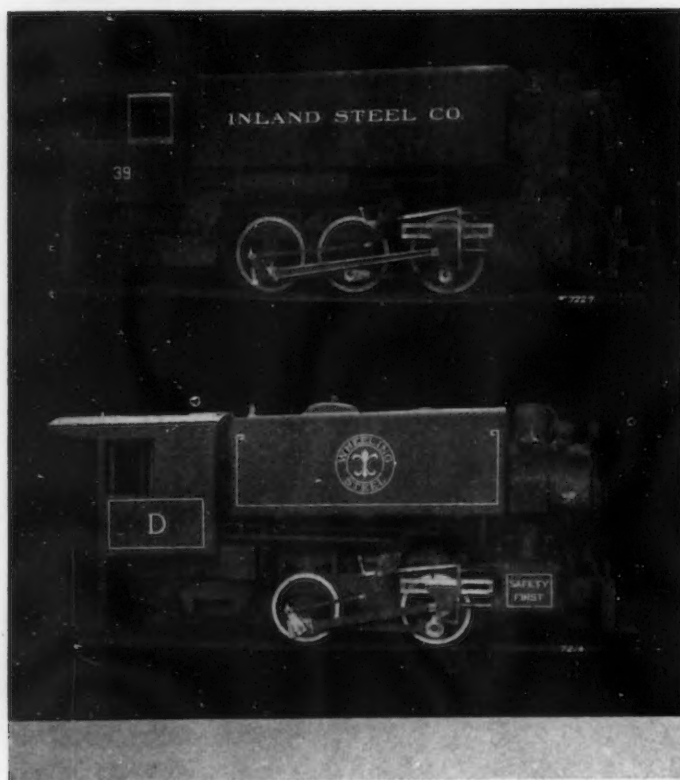


FIG. 31

**ROBBINS & MYERS** 1/2-ton electric hoist with rigid arm twist handle control.

# PORTERS are dependable!



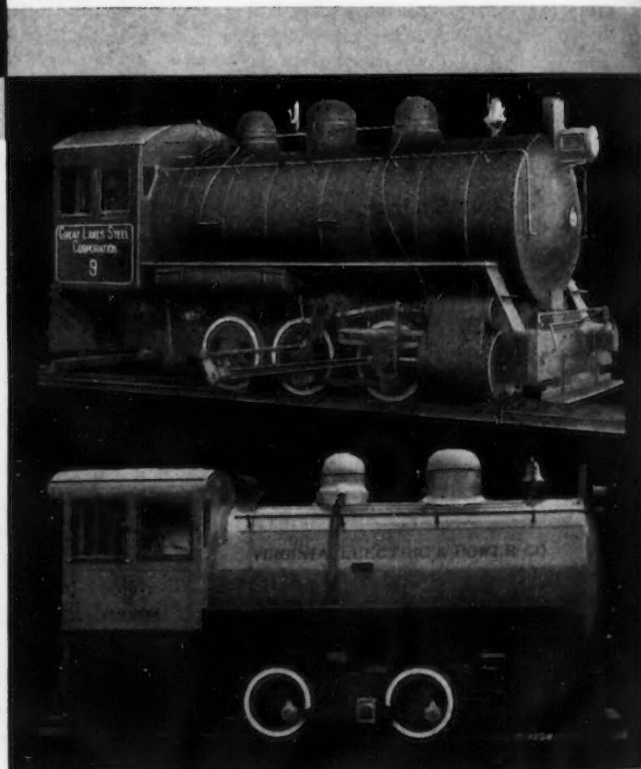
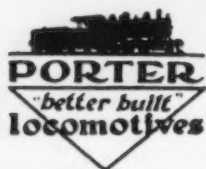
SEVENTY YEARS OF TRADITIONAL PORTER QUALITY AND PORTER CRAFTSMANSHIP BACKS THE POWERFUL PORTER OF 1937 . . .

For yard service and switching, PORTER STEAM LOCOMOTIVES are unexcelled for performance and low maintenance—proved by their splendid service record in many of the country's largest steel plants.

## FIRELESS STEAM LOCOMOTIVES FOR ECONOMY AND SAFETY

For yard switching and inside operation the PORTER Fireless Steam Locomotive is ideal, backed by a record of Steam economy and low maintenance costs unapproached by any other type of industrial haulage. It is silent in operation, requires no fire, emits no smoke to annoy crane operators.

Investigate Porter possibilities as applied to your hauling requirements.



## H. K. PORTER COMPANY

Established 1866, PITTSBURGH, PENNSYLVANIA

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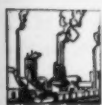
# STEEL MILL EQUIPMENT

*Nineteen thirty-six ushered in what will undoubtedly prove to be the greatest era of steel mill improvement that the world has yet seen.*

By T. C. CAMPBELL

*Pittsburgh Editor, The Iron Age*

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THE desire on the part of steel companies to continually improve the quality of their products and yet maintain efficient operation is the major reason for new additions and modernization of steel mill equipment. Stringent consumer requirements still remain to serve as an additional impetus. Without the business to supply the money, such improvements were curtailed considerably during depression years. Changes for the better cast their shadow in 1935, actually made their appearance in 1936, and now the prospects for equipment buying in 1937 are exceptionally bright. In fact, when

the figures are all in, it will probably be found that 1936 and 1937 will go down as one of the greatest periods of replacement and modernization in steel history. With changes taking place from blast furnace to finishing end, reliable and conservative estimates place expenditures for these two years at a half billion dollars or better.

From present indications there is no reason why the program of progressive replacement and new installation in the steel industry will not extend much farther than 1937. Reawakening of capital or heavy goods production will require constant rebuilding on the part of steel companies. So much has been discovered and learned during the past several years that could not be turned into action because of the financial position of the companies, that wholesale

changes are bound to take place for years to come. Projects now being carried out and those planned for the coming year are fundamental in nature and are indicative of the absence of the "defeatist" attitude on the part of the country's largest industry.

## Continuous Mills Still Being Built

The flood of continuous mill installations continues, and orders placed for hot sheet-strip mills in the last quarter of 1936 probably herald the end of such projects for the time being. Looking back it can be said that this phase of equipment building has been one of the greatest in machine history. The start of continuous mill installations was symbolical of the forward march in the steel industry and its influence has spread to other types of equipment.

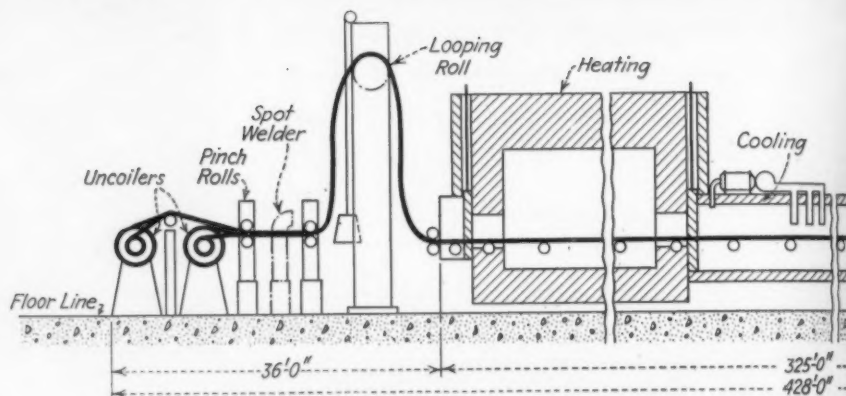


**N**O over-capacity here. View at the runout tables in a recently installed continuous mill. Tremendous demand for steel makes such scenes common.  
(Courtesy, Mesta Machine Co.)

The cycle in equipment building can probably be roughly classified as follows: Continuous hot mills, cold reducing mills, perfection of auxiliary equipment, modernization of older equipment not yet ready to be scrapped, installation of mills other than for lighter material.

At present we are emerging from the continuous hot mill stage and are in the midst of cold mill installations which will probably continue for a year or so owing to the rapid changeover from hot rolled tin plate to the cold reduced grade.

Announcements so far indicate at least three large up-to-date continuous mills will be constructed, which will also include cold reducing units. All progress gained in installations to date will be consolidated in the mills now under construction. Bethlehem Steel Co. is building a 56-in. mill at Sparrows Point to round out an expansion program embarked on some time ago. This mill will be capable of producing about 600,000 tons of flat rolled products annually. It will, like others of its kind, be extremely flexible and in addition to making standard size sheets



and strip, will roll light plates and hot strip for tinning.

Republic Steel Corp. is building a 96-in. mill near Cleveland. This mill will roll sheets up to 90 in. with an estimated capacity of 700,000 tons annually. Late information has indicated that the Republic Steel Corp. has enlarged its plans to enable the mill to roll sheets up to 92 in. by making the hot and cold mill constructions 98-in. mills.

Tennessee Coal, Iron & Railroad Co. has under construction at Birmingham, a 48-in. hot mill capable of an annual production of 300,000 tons. It is understood this mill, in addition to making sheets and strip, will roll plates, having a reversing roughing stand similar to the giant Homestead mill of Carnegie-Illinois Steel Corp. The Tennessee company is also going into production of tin plate and

will construct cold reducing mills for this product.

Two mills recently completed are the 96-in. mill at Jones & Laughlin Steel Corp., Pittsburgh, and a 100-in. plate mill at the Homestead works of Carnegie-Illinois. With these new mills in operation in the Pittsburgh district, it is expected that the diversification of products will be changed so that this locality will operate closer to the rate of the country as a whole during times of subnormal total steel production.

While the Jones & Laughlin mill is one of the largest of its kind in the country and is designated as a sheet-strip mill, the management expects to make it extremely flexible. Part of its 720,000-ton annual capacity will be utilized in rolling lighter gage plates. Demand for lighter gage plates by railroad car builders and growing restric-

tions on surface and tolerance place the hot continuous mills in a preferred position over older type equipment. Also to be rolled on this mill is skelp for pipe production and, in addition, part of the capacity of the mill will be used for producing hot strip which will be cold reduced and tinned.

The 100-in. plate mill at Homestead, Pa., has also been built so as to respond to flexibility of operation. The mill is semi-continuous in that a reversing roughing stand precedes the finishing stands. It is capable of rolling plate 20 x 90 in. and the gages will run from 3/32 in. to 3/4 in. inclusive. One reason for the construction of this mill was the growing demand for

large auto body sheets and material for railroad cars. The mill will roll in addition to regular carbon steels, special high-tensile grades developed by the United States Steel Corp. Capacity on an annual basis is about 729,000 tons. If necessary, it is possible to finish plates up to 1/2 in. thick on the roughing stand. These plates can be completed in three or five passes and sent through the finishing stands as "dummies." Provision is also made for a coiler at the end of the finishing stands in case operating conditions later require the use of the mill for hot rolled strip in coils.

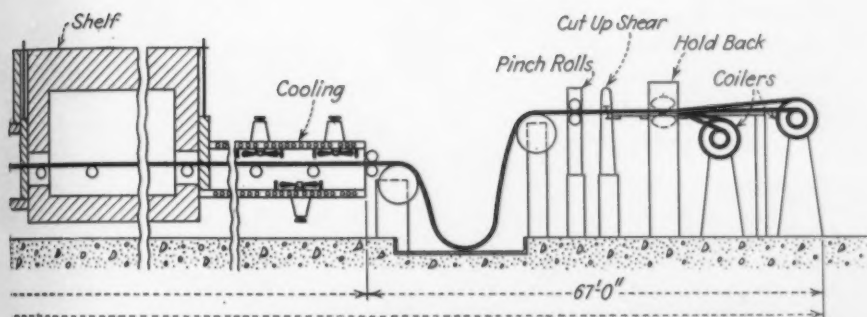
In addition to orders for cold reducing units coincident with hot

mill contracts, builders are busily engaged making cold reducing tin mills to supplement hot strip mills already installed. There has been a rapid growth in the demand for cold reduced tin plate.

It is confidently predicted that installations of cold mills for reducing strip for tinning will continue until a substantial part of present hot mill capacity is completely supplanted. Some companies whose plans called for rapid elimination of the hot mills were unable to achieve their purpose because of the sustained and growing demand for tin plate.

### Attention Centered on Auxiliary Equipment

Up to the present time the center of the equipment stage has been taken by continuous mills and cold reducing units. Now that machinery for actually deforming the slabs has been perfected to a high degree, there still remains room for improvements and new ideas as far as the auxiliary equipment is concerned. Much has been done along this line but equipment manufacturers are continually experimenting on improved machinery. Constant tightening of consumers' requirements as to sizes, tolerance, finish, etc., points to a long period in which emphasis will be placed on such things as flying



ABOVE

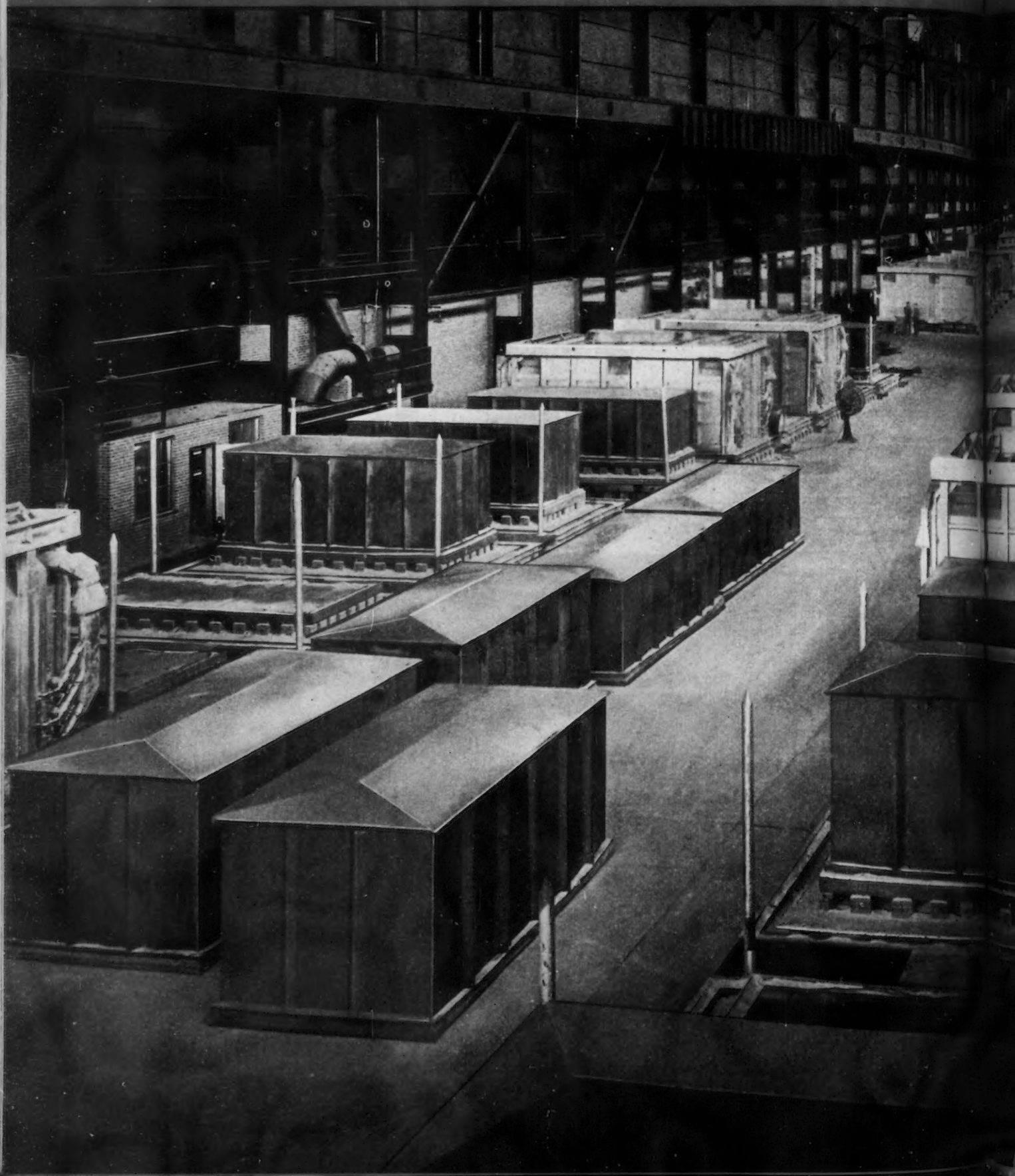
**S**CHEMATIC layout of new continuous bright normalizing furnace.

RIGHT

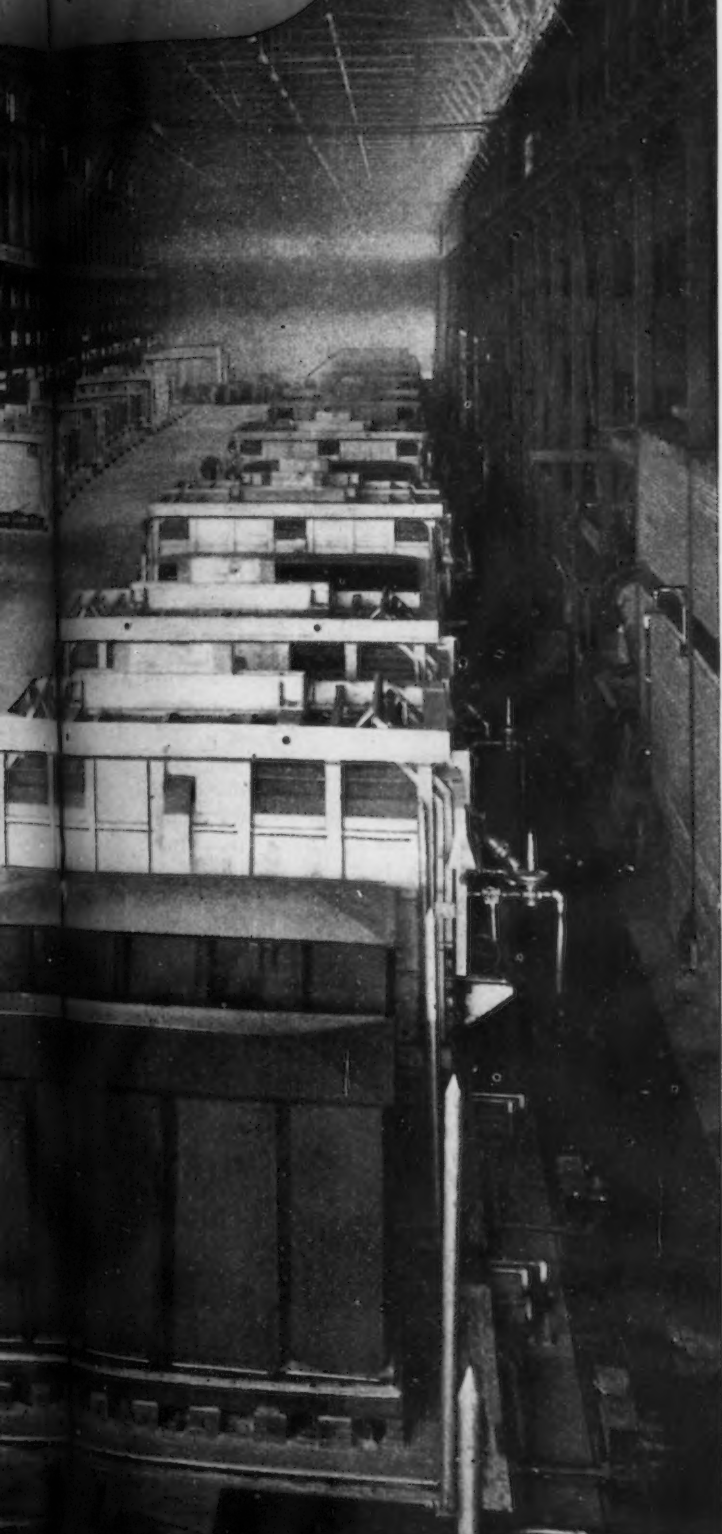
**V**IEW of a new 14-in. blooming mill in the Pittsburgh district, showing the all welded manipulator receiving an ingot from the soaking pits.



*There are 36*  **HORIZONTAL**  
**TUBE ANNEALING COVERS IN**  
**MODERN** *sheet and strip mill*



**RADIANT**  
**THIS**  
*now!*



● All that steel men learned from generations past, all that they know today went into the building and equipment of this modern new sheet and strip mill early last year. Among the important installations for production were 30 SC Horizontal *Radiant Tube* Annealing Covers. Recently six more were added as mill capacity was taxed. Today these 36 SC units are handling the entire production of this great mill with outstanding efficiency as to high speed of production, uniform quality of product and economy of maintenance and operation.

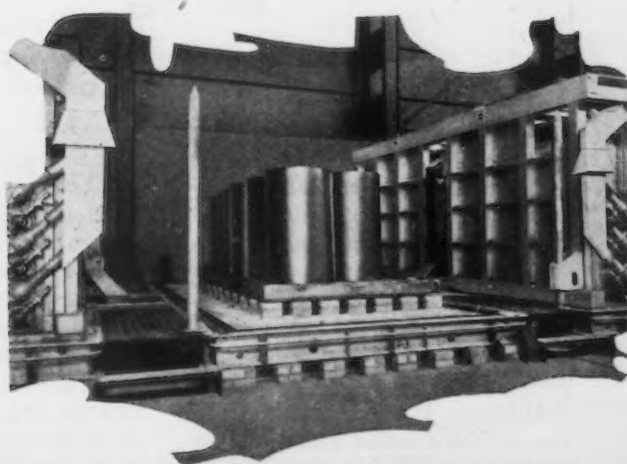
Invariably SC Annealing Covers deliver the highest quality of work at the lowest cost per ton annealed—a fact proved many times over during the past three years. Longer gas travel, greater heat transfer, precision and ease of control—all advantages are directly traced to SURFACE COMBUSTION engineers' experience in building steel mill equipment.

From top to bottom, and end to end, SC Horizontal *Radiant Tube* Annealing Covers permit an exactness of control in the heating zone that has no counterpart in fuel efficiency and uniformity. SC floating tube construction eliminates distortion or stress in tubes from expansion under heat, maintaining full efficiency, avoiding expensive maintenance.

SC *Radiant Tube* Annealing Covers, round and rectangular types, are available in standard sizes for coil, strip and sheet requirements. An SC Engineer will call to give you facts and figures if you like.

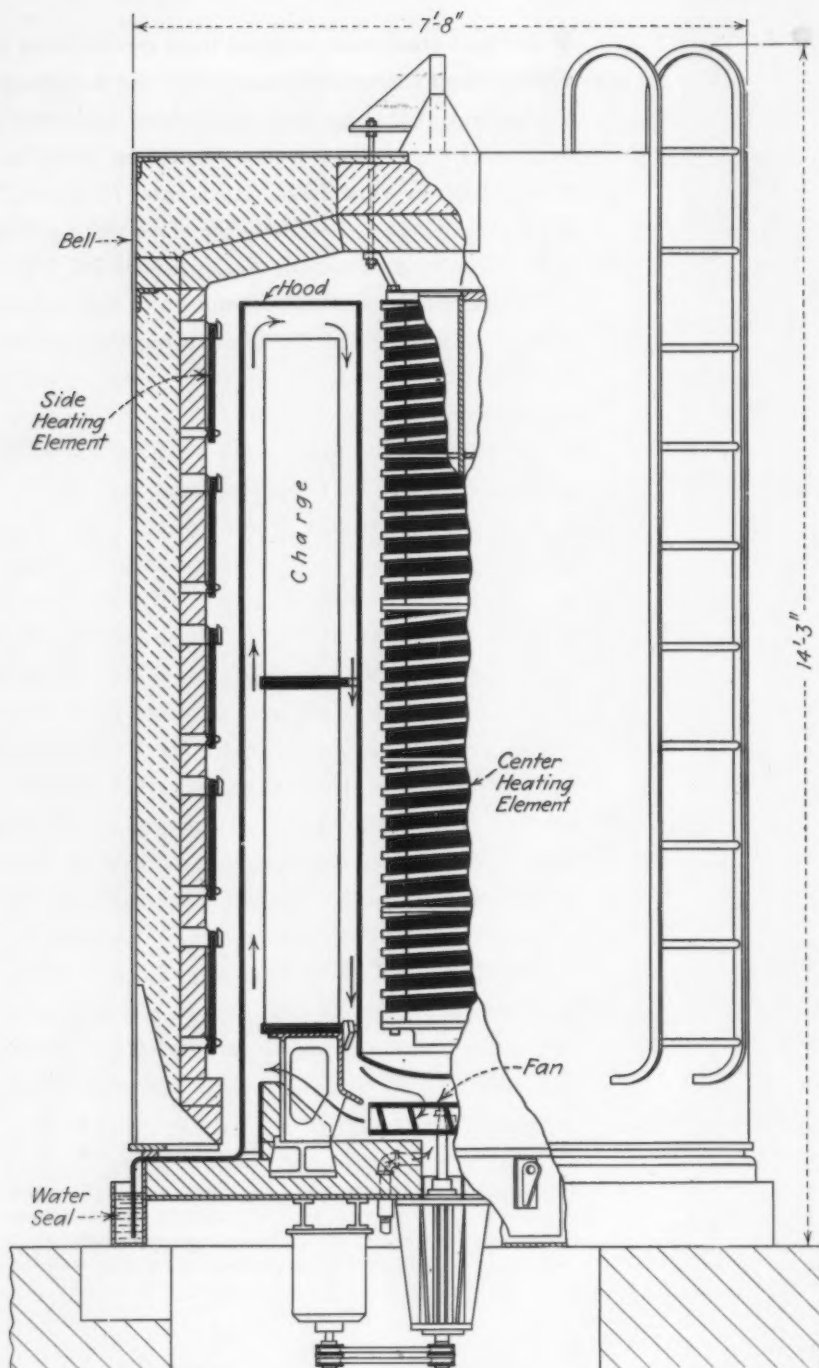
SURFACE COMBUSTION CORPORATION... Toledo, Ohio

● A battery of SC DX Gas Preparation Units, each of 15,000 C. F. H. capacity, provides the controlled atmosphere for these 36 SC annealing covers. Below is shown an SC Annealing Cover base loaded with coils of strip before annealing cover is lowered in place by an overhead crane.



**SURFACE**   
**COMBUSTION**

Builders of... ONE WAY FIRED  
SHAKING PITTS, WILLET HEATERS, RACK  
OR PAIR, ANNEALING, CONTROLLED  
ATMOSPHERE FURNACES, NORMALIZERS



**S**CHMATIC layout of bell-type annealing furnace.

shears, coilers, uncoilers, pickling lines, processors, annealing furnaces, normalizing furnaces and other equipment making for precision in producing steel. Last year did not see so many new ideas as much as it saw the putting into action of developments made in previous years.

Although the process uncoiler was perfected a few years ago, its use has grown widely during 1936. It often is found on the pickling line while at other plants it is a

unit by itself. The main purpose of this machine is to take out or prevent cross breaks in uncoiling. Although cross breaks are removed in cold reducing, there are many operations that do not call for cold reduced strip. One good example of this is the making of barrels. Cross breaks have been costly, both in time and material, but the use of a process uncoiler produces a strip that is free from these defects, and in addition is more ductile.

The principle of the processor is that the strip is put through an infinite number of breaks by passing through a roll which pulls the metal almost straight up and then down before final passage through rolls similar to leveling rolls. While this operation does not put cold work on the strip, such as is the case in cold reducing, there is a change in the steel as a result of the bending which takes the metal slightly beyond the yield point, thus imparting more ductility. It has also been found that this operation, on the average steel, delays aging for approximately two to three weeks. While some authorities maintain that processing is not necessary on steel which is to be cold reduced, other manufacturers claim that this treatment makes for a better cold reduced product. Still other makers assert the process uncoiler helps in breaking scale so that it drops off as a fine dust and speeds up the pickling operation.

#### All Welded Manipulator

Of interest because of the type of construction is an all welded manipulator on a recently built 44-in. blooming mill at a Pittsburgh steel plant. The unit is the first all welded manipulator to be built and consists of four movable platens. A cast steel head is supported by each platen and forms the sides of the roller table in the immediate vicinity of the mill. There is no rebound in the return of the tilting fingers due to the inclusion of a dash pot as part of the mechanism. The unit is built of rolled steel plates, billets and slabs, the thickness of which runs from 1½ to 4 in. while on those parts where greater mass was required, slabs measuring up to 12 in. in thickness were used.

Interesting also is the fact that this unit is operated hydraulically. As a rule, most manipulators recently built are controlled electrically. A pneumatic accumulator is part of the equipment and it is claimed by the company that this addition acts as a stabilizer or cushion, as well as a control device for the pumps. It is said that the action of the accumulator is less detrimental to the pumps also. The unit has been in operation for several months and officials are satisfied with the results obtained.

An automatic temperature re-



Size of Bearing  
30" O. D.  
20 $\frac{3}{4}$ " long  
18" I. D.



# PERFORMANCE RECORDS

*Caused this Preference!*

**88** OF THESE BEARINGS, for use on Roll Necks, are now being manufactured by Bantam to fill a single order. They are exact duplicates of Bantam Bearings which have proved their dependability through years of service.

Re-orders, like this one, based on carefully checked performance records — are the best possible gauge of merit in any product. They furnish convincing evidence of the **BIG SWING TO BANTAM.**



## THE BANTAM BALL BEARING CO.

(SUBSIDIARY OF THE TORRINGTON CO.)

**SOUTH BEND, INDIANA**

CHICAGO  
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NEW YORK  
ROCHESTER, N.Y.  
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SEATTLE  
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In Canada: DOMINION ENGINEERING WORKS, LIMITED, MONTREAL

**TAKE YOUR TOUGHEST BEARING JOB TO BANTAM**

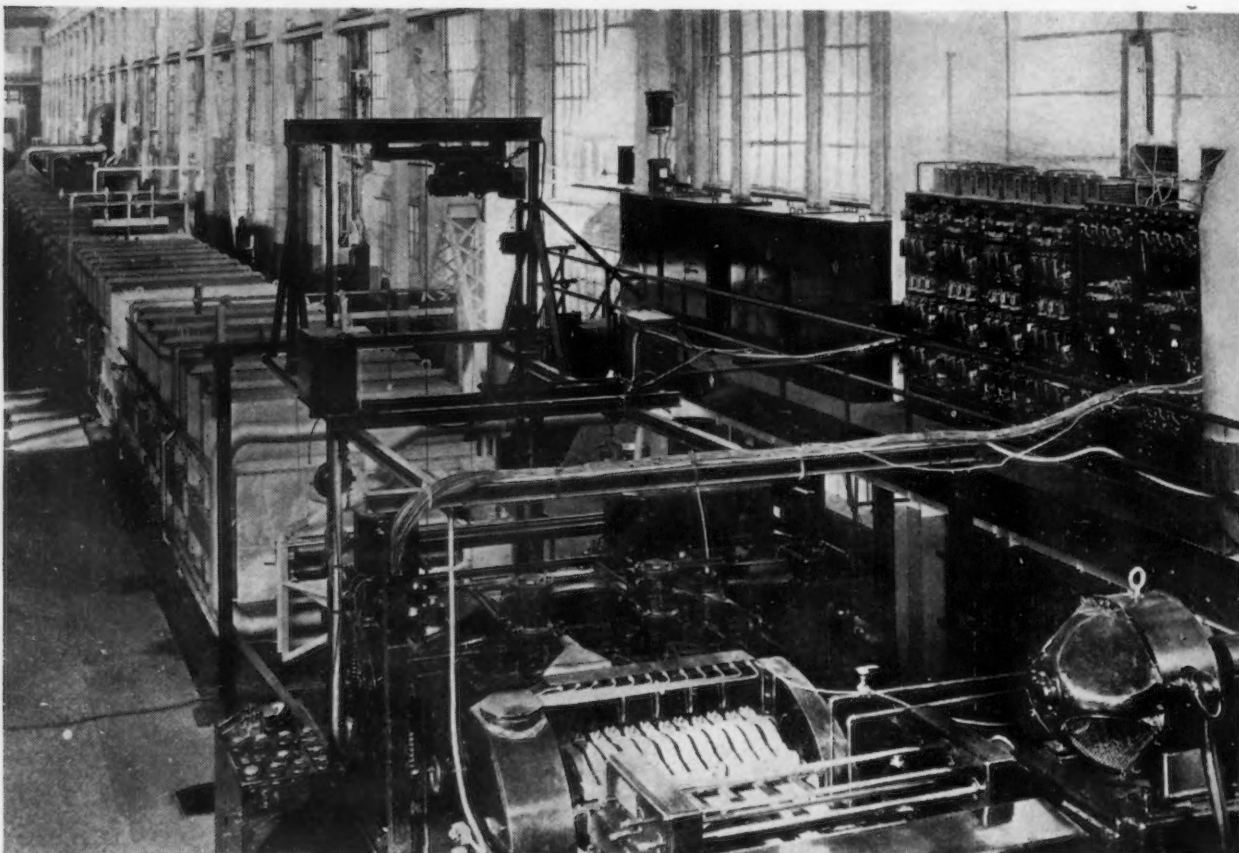
cording instrument utilizing the photoelectric tube or the "electric eye" is fast supplanting manual optical pyrometers around steel mills where exceptionally close temperatures must be determined. These are in use on continuous mills and other finishing or semi-finishing equipment. The instrument is especially suitable for recording temperatures of fast moving objects, indicating to full scale the temperature of a hot body in

makers, the use of this recorder rules out guesswork and results in a better roll life.

The unit is mounted in the housing posts of the new mills, while on existing installations it is welded to the housing posts at a location which will not interfere with the changing of rolls or the passing of the metal.

The principle involves the use of the same metal for the gage bar as the housing post in order

power, not only because of new installations but for electrification of older equipment. There are some cases where companies have increased the width of their sheet mills in order to keep up with the demand for wider sizes, while some of the smaller companies have added mechanical and electrical improvements to some of their mills in order to increase output. It is expected that this particular phase of equipment building will



**V**IEW of 5-ton per hr. continuous bright normalizing furnace. It is 230 ft. long. A similar installation, 335 ft. in length, with 7½-ton per hr. capacity, has recently been completed.

about half a second. In some plants a series of these units is rigged up to give a complete history of the steel from the time it is started through the rolls to the finish. Temperatures are recorded on charts for future reference and study.

Greater use of the pressuremeter has resulted during the past year. While this unit is part of some mills at the time of construction, it is possible to attach it to mills already in service. Inexpensive, it is a simple device to record the rolling loads of all types of hot and cold mills in order to balance the passes. According to the

that the thermal coefficient of expansion of the metals is as close as possible.

#### Equipment Being Modernized

In addition to purchasing new equipment, steel companies are making substantial investments to renovate and modernize mills already in operation. In the past year some companies have replaced engine drives with electric motors and the trend toward further electrification is going steadily forward. One large steel company has already placed contracts for two large turbines which will be used for generating additional

continue for quite some time, as many of the smaller companies which are unable to make large scale investments will be forced by competitive conditions to completely overhaul much of their machinery.

#### Smaller Steel Companies Considering Improvements

Higher prices for semi-finished steel, the possible scarcity of this item and the flood of continuous mill installations are causing some non-integrated mills to consider fundamental changes in their equipment. One company has under consideration the installation of

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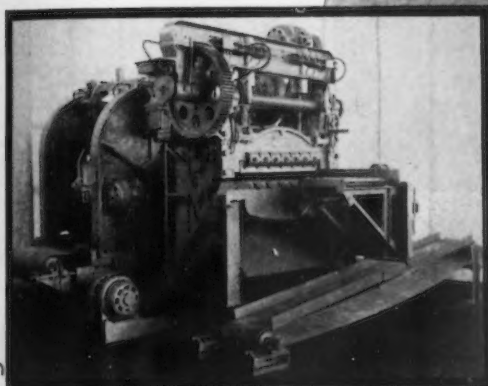
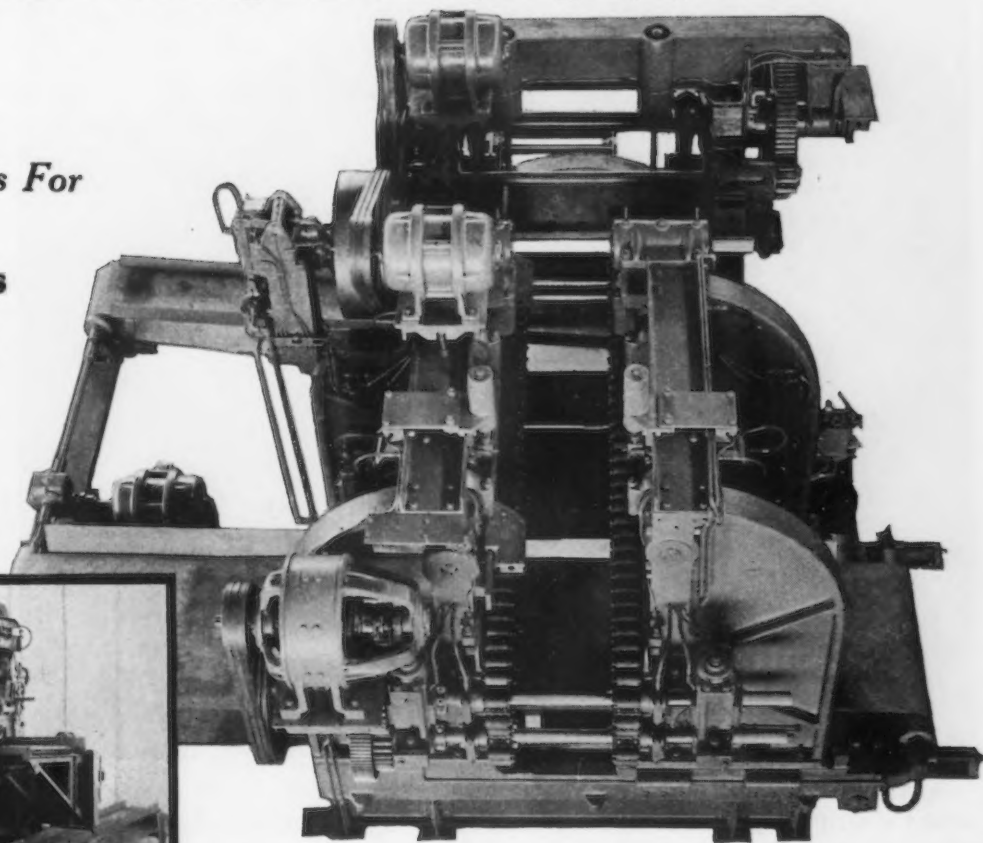
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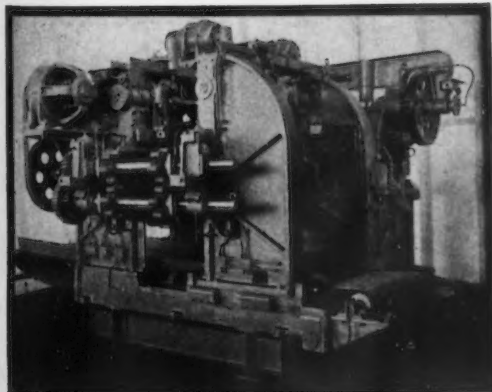
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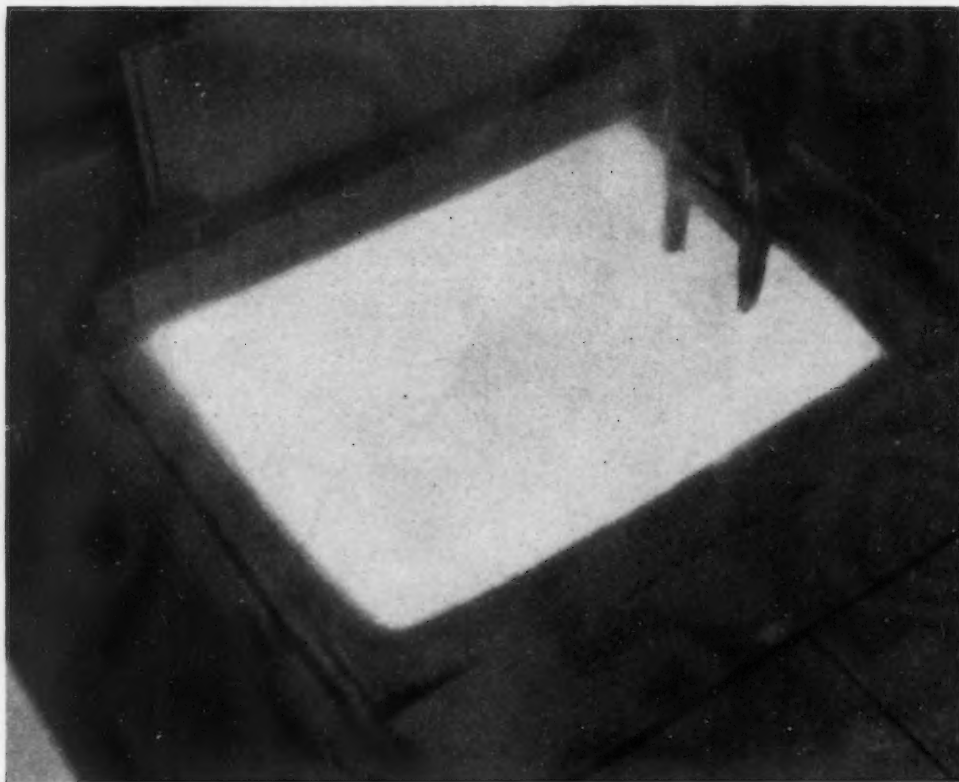
**THE STREINE TOOL & MFG. CO.**  
**NEW BREMEN, OHIO**

open-hearth furnaces, soaking pits and a combination breakdown and finishing mill. It is understood the plans call for breaking down 12 and 14-in. slab ingots on the first stand to about  $\frac{1}{2}$  in. in thickness, after which the steel moves to another stand where the hot-rolled strip is completed. For operations where the strip is to be sold in hot-rolled form, the engineers have

already been made which show that the plans are not only feasible but workable. Strip can be rolled down to 0.100 in. in thickness and the designers feel that a mill set-up of this type is the answer for the smaller manufacturers who are competing with the larger continuous mills.

A refinement of the two-strand breakdown and coiler type mills is

the single unit for both the breakdown and the finishing is provided. On this type of installation it is believed that a single stand setup is satisfactory when the material is to be cold reduced later, but a two-stand installation is more satisfactory as far as finish and gage are concerned when the product is to be sold in the hot rolled state. In the plans just described, the



REMOVING the first ingot from a new type soaking pit designed for increased fuel economy.

devised a plan using a three-high universal plate mill for the breakdown and a three-high coiler type mill for the finishing operations. According to the designers of this set-up, the special coilers do not involve the use of heating furnaces as is the case on the hot Steckel mill and it is claimed that by starting the rolling at the proper temperature the steel will still be hot enough to finish rolling. In those cases where the hot-rolled strip is to be cold reduced, plans are being furnished showing the special coiler as part of the universal plate mill, thus completing the breakdown and the finishing operation all in one stand. Various changes and additions have been made to the three-high mills in order to fit the complete plan of operation. The entire set-up depends on speed of operation and it is said some experiments have

being worked up for another steel company. In order to increase capacity and improve on finish, plans call for an addition of a two-stand four-high mill to take the strip after it has been reduced on the three-high hot coiler type mill. The gain in production by the addition of the two-stand four-high mill results from less working on the first two units.

Producers of the hot Steckel mill are busy making plans for some of the smaller units. One being worked up at the present time is for a company which has no capacity for plates, strip or tin plate but which is contemplating entering this field in a limited way. Equipment contemplated includes a universal plate mill equipped with hot Steckel type coiling furnaces and a cold Steckel mill. Since the company is to reduce its hot-rolled strip for tin plating,

hot Steckel coilers will be used in rolling strip but the same universal plate mill, by disengaging the coilers from the equipment, will produce 72-in. wide sheared plate and 48-in. universal plate.

At least three companies now have the intention to install equipment similar to that described above but it is also known that quite a few other smaller companies are very much interested. Their desire to make these changes does not seem to be as much a question of competing in volume with the larger mills, as it is more a case of bringing their own steel making costs down to such a point that they can economically carry on the manufacture of their products.

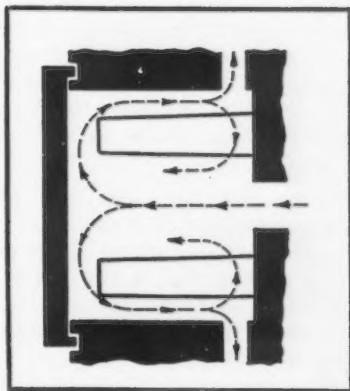
#### Other Rolling Mills

During the past few years, finishing and semi-finishing mills other than the continuous type

have been more or less neglected because of lack of capital and the ascendancy of the lighter steel products in the total steel production. However, during 1936 at least three large blooming mills were constructed. Equipment companies in building them applied many of the newer principles gained through experience in producing the continuous sheet mills. All of the blooming mills now being constructed are of the two-high reversing, electrically driven type, and modern day conditions have necessitated a much greater amount of attention on auxiliary equipment. This is necessary, not only because of the lack of space at some plants, but because of the flexibility in blooming mills, most of which can now make various sized blooms and slabs of all grades. There is little doubt that in the near future inquiries will be out for the construction of heavy plate and shape mills. Makers of this type of equipment are understood to be all set with plans and specifications which are calculated to bring to this type of equipment the same progress as exemplified in the continuous sheet and strip mills.

#### Normalizing Furnaces

Considerable interest is being evinced over the performance of a new 7½-ton per hr. continuous bright normalizing furnace which was recently completed at an automobile company's steel plant. This furnace is along the general lines



SCHEMATIC drawing of new soaking pit, showing gas flow and position of ingots.

of one built during the latter part of 1935. The one installed at that time is a 5-ton an hr. furnace, 230 ft. long with a connected load of 1250 kw. It handles 20-gage sheet 48 in. wide.

The new 7½-ton an hr. furnace is 325 ft. long with a connected load of 2335 kw. and bright normalizes 20-gage sheet up to 56 in. wide. Both of these furnaces are the result of intensive experimentation toward the possibilities of the continuous normalizing of auto body sheet. Where the average cycle in bell annealing takes from two to five days, cycles ranging from 9 to 15 min. have been obtained by using the continuous 5-ton normalizing furnace.

Rockwell hardnesses of 50 to 60 on the B scale were obtained, which values, while higher than

are obtained by bell annealing, are, in the opinion of those familiar with the operation, low enough that normalizing material can be substituted for bell annealed material and commercial processing except for the deepest draws. It is expected that much new data regarding the continuous normalizing process and its future possibilities will be available in the near future after the recently installed 7½-ton furnace has been in operation for a while.

This larger furnace is designed to permit a wide variation of time temperature cycles, particularly from the end of the initial heating period to the beginning of the final cooling period. The principles involved are quick heating to 1740 deg. F., a fast cooling to an intermediate temperature range (1020-840 deg. F.), a cooling at a slower controlled rate, and finally a relatively rapid cooling to approximately 280 deg. F. These figures apply when using a low-carbon steel sheet.

A schematic layout of this furnace and auxiliaries is shown on these pages. The entire furnace has a gas tight steel shell, and the atmosphere within the furnace is controlled and consists of partially burned coke oven gas. This assures a bright, clean surface. The material is carried to the furnace structure in coil form from the cold mills, and no recoiling or cleaning operations are required.

The bell type electric furnace and the gas fired furnace with

## Automatic Weighers Reduce Costs

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By Streeter Amet Company

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radiant combustion tubes are much in demand and quite a few installations were made in 1936 of both these types. Increased sheet production and new mill installations have also brought a demand for the permanent box-type annealing furnace.

#### New Soaking Pit Design

A new soaking pit has been designed recently by a Pittsburgh concern and an installation has al-

ready been made. The pits are simple in structure and adaptable to any type of fuel. Low fuel consumption is obtained by means of a recirculation gas flow, recuperator design, automatic firing, and an efficient cover.

In the new pits, the flame enters the combustion chamber as a natural convection current through a port in the hearth and the ingots which surround the port are not directly in the path of the flame.

After release in the pit, the velocity of the gas increases rapidly, producing a fountain-like envelope completely surrounding the ingots. Induction recirculates a part of the comparatively cooler gases in the furnace and the waste gases are removed through spaced outlets located near the corners of the side walls, slightly above the coke braize. The gases from each outlet pass into the recuperator and from there to the stack.

According to the manufacturers of this pit, the actual fuel consumption per ton of steel heated is exceedingly low. Fuel rates quoted on 18x21 in. bessemer ingots averaging 45 min. in the mold are 200,000 B.t.u. a gross ton on 12 ingot (37 gross ton) charges. On full charges of 12 cold ingots, the rate is 1,400,000 B.t.u. a gross ton.

A specially designed seal-type cover is a flat, refractory arch moving vertically in relation to a carriage which in turn moves on a level notchless track. A master switch controls the movement of the carriage in cover, synchronizes fuel, air supply and draft in succession to avoid heavy heat losses during charging and discharging. The manufacturers also claim elimination of "washing" of the ingots. Temperature control is also a feature of the installation as well as atmospheric control.

Constant improvement with reference to type of fuel used, efficiency, etc., has been made in other specially designed soaking pits, such as the one-way fired and the circular type. A recent installation of the latter, involving nine pits, was made at one of the large steel companies. The main feature of recently developed soaking pits involves the principle of precision control similar to that obtained in heat-treating furnaces. A sand-sealed cover is a new development for the one-way fired soaking pit in order to cut down heat loss when charging or discharging.

Improvements are also being made in the regenerative type soaking pits to conform with the results obtained in some of the other types of installations. In view of the exceptionally high operating rate and the fact that soaking pits are becoming increasingly important because of higher quality steel making, considerable construction on this type of equipment is expected in the next few years.

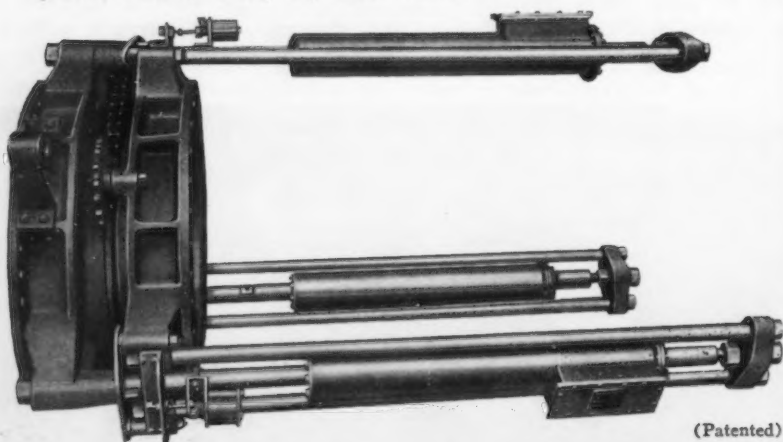
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# HEAT TREATING AND REFRACTORIES

*Heat treating of entire sections  
as well as surfaces has under-  
gone improvements tending to  
increase speed, accuracy and  
scope of application and use.*

By DR. CHARLES R. AUSTIN

*Consulting Metallurgist\**

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IN the fullest sense the term heat treatment, as applied to ferrous materials, may be said to refer to any operation, or combination of operations, involving the heating and cooling of a metal in the solid state for the purpose of obtaining certain desired mechanical or physical properties. In the article which follows it is proposed to discuss some of the most important features of what may be considered to be two distinct phases of the subject. These two phases are:

(1) Heat treatment of the complete section of the alloy as in annealing, normalizing, quenching and tempering operations, whereby various properties are obtained ranging from the softest condition

in the annealed or stable state to the hardest condition in the quenched unstable or metastable state. This section will also include reference to certain precipitation hardening characteristics of alloys which may develop as a result of prolonged periods at room or elevated temperatures. In either case the hardening results are essentially dependent on the previous thermal history of the metal, and the "tempering" operation with precipitation hardening alloys is a hardening treatment as compared with the softening effect usually associated with any tempering treatment.

(2) Heat treatment applied to the surface conditioning of an alloy where, by a change in composition induced by heating, the properties are enhanced as regards resistance to wear, to chemical or ordinary atmospheric corrosion, and to corrosion attack (frequently oxidation) at elevated temperatures.

The first phase, heat treatment of the complete section, may be further broken down into a subdivision designated as hardenability. This subdivision of the first phase of the subject deals essentially with the control of the hardness of steels and the depen-

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\*And associate professor of metallurgy, Pennsylvania State College, State College, Pa.

dent properties, such as toughness. It has been well known for many years that when carbon steels are heated to a bright red heat, all the carbon dissolves in the iron and forms a solid solution of carbon in gamma (face-centered) iron. On slow cooling, the iron changes to ferrite (body-centered lattice) and the carbon is thrown out of solution. However, rapid cooling or quenching of the alloy tends to prevent this precipitation and a hard structural form (martensite) results. Tempering of a steel quenched in this manner tends to permit the structure to revert to the most stable form, comparable to slow cooling, and a softer alloy results.

While these elementary facts had been known for many years, it was also known that some other factor might have a profound effect on the results obtained from such heat treatment. Thus steels of apparently identical chemical analysis heated and cooled in exactly the same way did not respond similarly, and marked differences in hardness and toughness were obtained. It was considered that this was due to some ill-defined property known as timbre, or body, inherent in the steel. This difference in the behaviour of steels of similar analysis was readily noticeable in the depth to which the steel would harden on quenching. When a bar of carbon steel, unless small in section, is quenched in water from the gamma solution range, a certain "critical rate of cooling" must be exceeded if the hard martensitic structure is to be obtained. Since the center of, say, a 2-in. diameter bar cannot lose heat fast enough to attain this "critical rate," it must necessarily be always relatively soft despite the quenching medium used. Thus we have a hard case and a softer core.

Now the important feature is that this hard case does not always have the same thickness or, in other words, the "depth of hardening" is not always the same with steels of apparently similar composition. Since it may be taken for granted that the rates of cooling are constant for similar sized sections of the alloy, it began to be realized that for some reason the "critical cooling rates" must be different despite apparent similarity in chemical composition.

The appreciation of this simple fundamental conception has unquestionably been the most important advance in the heat treatment of steel leading to uniformity of product during the last decade.

Perhaps the first important work along these lines was that by Portevin and Garvin in 1919 which gave rise to the conception of "critical cooling rate," although it was not until about the time of the classical work of Bain and his co-workers published in 1932, that it began to be generally appreciated

pearlite—a mixture of ferrite and cementite (iron carbide).

Herty and his coworkers have recently contributed the most important data on the first of these reactions, and the term "specific reactivity" has been used as a quantitative index of rate of ferrite rejection. Suffice it to state that Herty definitely established a relationship between grain size and rate of ferrite rejection. A simple picture of the mechanism can be readily suggested when it is recalled that decomposition begins

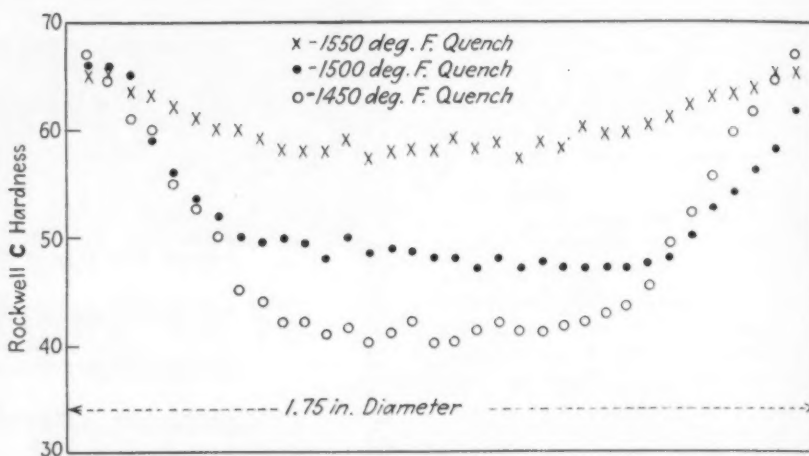


FIG. 1

**E**FFECT of quenching temperature on the hardness penetration of a 1 $\frac{3}{4}$ -in. diameter SAE 52100 steel rod (1.05 C, 0.39 Mn, 0.25 Si and 1.40 Cr). Case hardness is about the same in the three series of tests but hardness penetration is profoundly affected by quenching temperature.

that grain size had a profound effect on hardenability.

#### Role of Grain Size

The term grain size has reference to the size of the austenitic grain at elevated temperatures immediately prior to quenching, and it is the effect of the austenitic grain size on the rate and on the temperature at which the transformation to ferrite and cementite occurs that may make the profound difference in the behavior between the critical cooling rate or hardenability of steels of similar chemistry.

In hypoeutectoid steels (less than 0.9 per cent carbon) there are two important contributing factors involved in the transformation which occurs on cooling. First to be considered is the ferrite precipitation or rejection, occurring between the upper and lower critical points, and second the transformation of the austenite, saturated with respect to carbon, into

at the place of maximum internal energy—the grain boundary. Thus with small grains we have considerably more grain surface than with large grains and hence the facility to decompose, both as regards temperature and rate, is considerably enhanced. Indeed Dr. Herty states that ferrite formation is directly proportional to grain surface. Hence austenitic grain size modifies the critical cooling rate.

A similar picture may be portrayed in considering the second factor, namely, the eutectoid transformation from the gamma saturated solid solution.

Therefore it is possible to summarize by stating that we are now beginning to understand why the hardening characteristics of steels of similar chemical composition may vary appreciably under identical conditions of heat treatment. The inherent grain size of the austenite prior to quenching has an important effect on the critical

cooling rate and hence on the hardenability of the alloy. In general, fine grains readily transform and consequently more rapid cooling rates are necessary in order to obtain the very unstable hard martensitic structure. Fine grain steels are therefore shallow hardening steels.

Manifestly it is now realized that it is as important to know the inherent grain size of the steel as it is to know the chemical composition. Many methods have been suggested for experimentally de-

ferences and this is particularly true in reference to the development of a mixed grain size.

However, up to the present, the evidence appears to point strongly to the hypothesis held by many metallurgists that the primary reason for fine grained steel—that is, for the existence of steel which may be heated well above the upper critical temperature without marked evidence of coarsening—lies in the inhibiting power on grain growth of insoluble non-metallic particles distributed through-

a depth hardness of 0.20 to 0.25 in. of 55 Rockwell C or above.

The material was received in a machineable condition, that is, with a spheroidized structure. The pieces were normalized from 1600 deg. F. and heated 1½ hr. at the quenching temperature. They were then agitated violently for 5 sec. in water, held at 110 to 120 deg. F., and immediately transferred to a light oil at 90 deg. F. and agitated until cool. If drawn they were held 2 hr. in oil at 375 deg. F.

The graphs shown in Fig. 1 record the data obtained by measuring the hardness across the section of the bar after quenching as described, from 1450 deg., 1500 deg. and 1550 deg. F. The hardness of the case is approximately the same in the three series of tests but the hardness penetration is profoundly affected by the quenching temperature.

In Fig. 2 the data obtained by tempering these bars at 375 deg. C., after the 1450 deg., 1500 deg. and 1550 deg. quench are recorded. Again the effect of quenching temperature on core hardness is at once evident.

The attention of heat treaters should also be drawn to the modern conception of the effects of alloying elements on reaction rates or critical cooling velocities, and, hence, on the hardenability of steel. The recent work of Houdremont on the effect of tungsten and vanadium on hardenability is particularly instructive. In this investigation he dealt with carbides of low solubility or carbides which enter into solution in the austenite at a slow rate. In such steels it was shown that if the time and temperature conditions are not such as to permit the complex carbides to be taken into solution, the alloy may be shallower hardening than the plain carbon steel. This means that the critical cooling rate is higher under such conditions, for the alloy steels. With complete solution of the carbides there are no longer nuclei present to facilitate carbide rejection and hence decomposition of the solid solution and accordingly the true slower critical rate of cooling of the alloy steel is permitted to manifest itself. Deeper hardening results.

### Commercial Developments

The first phase, heat treatment of the complete section, may also

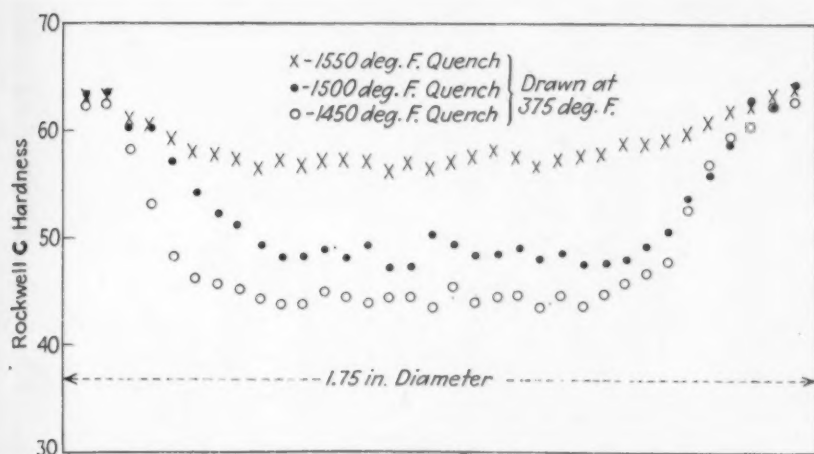


FIG. 2

**E**FFECT of quenching temperature on the hardness penetration of a 1¾-in. diameter SAE 52100 steel rod, after subsequent tempering for 2 hr. at 375 deg. F. As in Fig. 1, the effect of quenching temperature on core hardness is again evident.

termining this characteristic grain size but much research remains to be done on the subject. The old McQuaid-Ehn test serves excellently to determine the carburizing qualities of a steel but it has serious objections when considered as a means of determining the inherent grain size of the steel under normal heat-treating (annealing) conditions. Various etching methods along with special interrupted methods of cooling are proving valuable as determinative methods.

### Grain Size Controlled by Aluminum

The question naturally arises as to why these steels react in such a way that they may be variously classified as coarse, medium or fine grained, and particularly why certain types of steels (such as the medium-manganese steels) are prone to reveal a mixed grain size—frequently spoken of as “duplex structure.” Uncertainty still apparently exists as to the fundamental explanation for these dif-

ferences. Thus the addition of aluminum during the final stages of deoxidation of the molten steel results in a dissemination of minute particles of insoluble alumina in the solidified ingot. Accordingly aluminum additions serve as an excellent means of control of grain size.

While the above comments are by no means complete and while no final statement can be made on this most important phase of heat treatment, it is believed that they represent the most widely held conceptions on the subject.

Perhaps an example of the effect on hardness penetration of annealing temperature prior to quench may be of interest. The purpose of the experimental treatment was to produce a hard surface and a relatively soft core in rather large sections of SAE 52100 steel, having a 3-5 A.S.T.M. grain size. The section used was a 1¾-in. diameter bar. A surface hardness of about 60 Rockwell C with a 40 to 45 Rockwell C core was desired, with

be broken down into a second subdivision entitled, commercial developments. Many commercial developments can be recorded in this field but a number of observers consider that the continual strides in heat treating in controlled atmospheres represent the notable advance of the present day. A remarkably concise yet complete critical analysis of the present state of the science, or art, of heat treating in controlled atmospheres has recently been presented by

malizing furnaces where atmospheric control is important in such commodities as tin plate and automobile body sheets. Some changes in design are certain before completely satisfactory units are evolved. Economic developments depend largely on cheap gas, low gas consumption and selection of the right alloys for fabrication of the moving furnace parts. Uniformity of product is of the utmost importance in this operation.

The use of propane as a pro-

and by adjusting the burner orifices it is claimed that it has been possible to make tubing with a virtually scale free surface.

What is claimed to be the largest continuous electric furnace in the world has been installed at the Ford Motor Co. The purpose of the furnace is to bright normalize automobile body stock in the shortest cycle which will give maximum ductility and softness. The strip is fed continuously into the forming presses and the output is ex-

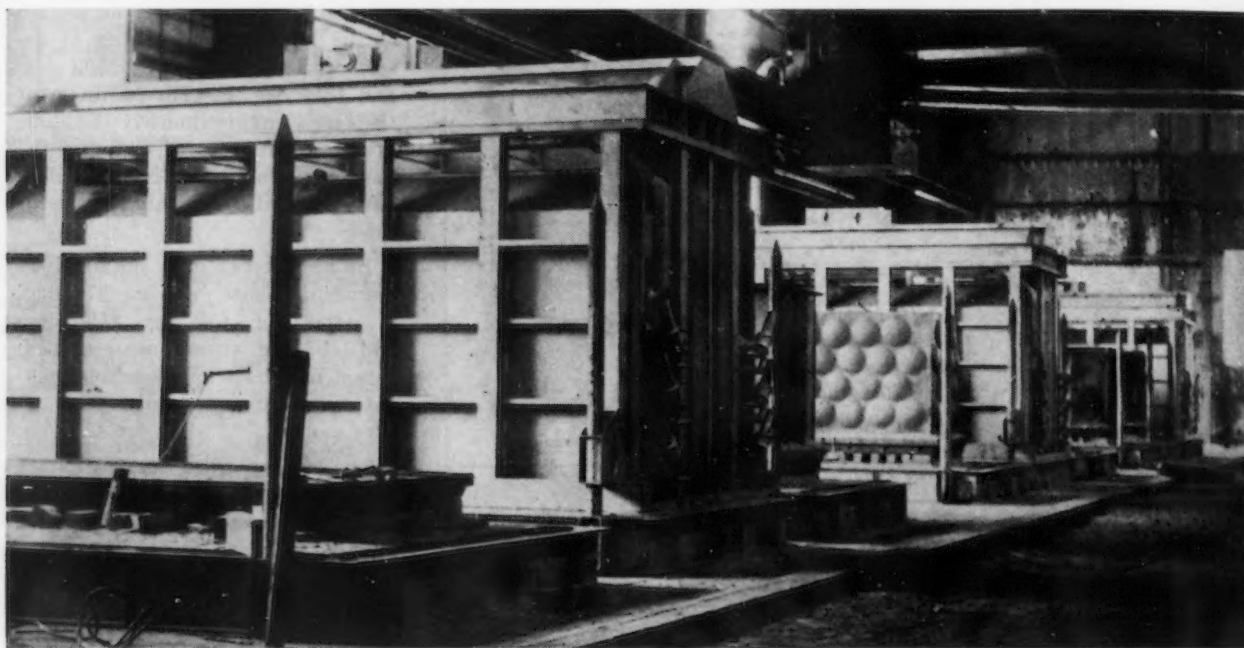


FIG. 3

THE three rectangular covers shown here are used for the bright annealing of steel sheets. The heat energy is supplied by means of horizontal radiant tubes shown on the ends of the covers. Photo by Surface Combustion Corp.

Gillett in what he has termed a correlated abstract of the subject.

Protective atmospheres in general refer to a gas or to gases which are introduced into a furnace for the purpose of protecting from oxidation the surface of the materials to be heat treated. An important new development in controlled atmospheres relates to the introduction of carbonaceous gases whereby the surface of the steel is carburized.

As regards general annealing processes, modern furnace design in box annealing has permitted the temperature gradient within the charge to be greatly reduced by attention to burner and flue arrangement and design. Much attention continues to be directed to continuous gas and electric nor-

protective atmosphere appears to be increasing. The propane is subject to partial combustion in a refractory tube containing a catalyst. Under proper conditions the resulting gas is high in nitrogen but retains its reducing characteristics.

It is not long since the heat treatment of seamless tubing was regarded as economically impracticable. It was considered that enhancement of the physical properties of the tubing must be obtained by the addition of small amounts of alloying elements, particularly manganese, but any improvement had to be obtained by controlling the finishing temperature prior to air cooling. Recently successful continuous normalizing of 40 ft. lengths has been reported. The furnace is fired with natural gas

pected to be  $7\frac{1}{2}$  tons per hr. for 56-in. wide strip.

Another important development which must be recorded is the use of radiant tubes in annealing covers in which a special atmosphere is used for the bright annealing of steel sheets. The radiant tubes are of a hair pin type construction and are placed along the inside walls of the heating chamber, the work being protected from atmospheric oxidation by an inner cover. One burner is fitted to one end of the tube while an aspirator is fitted to the discharge end. The burner is a combination of diffusion combustion, and premixed type of combustion. High efficiency for greater heat transfer, more accurate control of heat distribution, and absolute control of uniformity are

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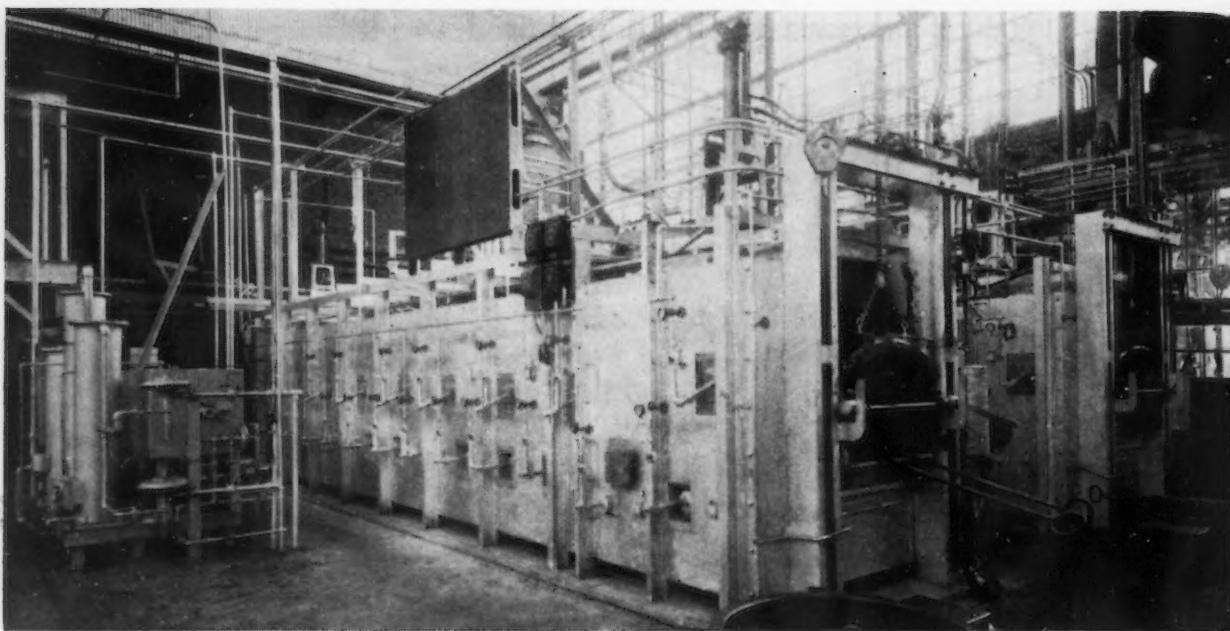


FIG. 4

**T**WO recent installations for continuous gas carburizing. The gas preparation unit is at the left of the picture. Photo by Surface Combustion Corp.

claims made for radiant tube annealing covers. These heating chambers equipped with horizontal radiant tubes are shown in Fig. 3.

In the general field of heat treating the prevention of internal fissures in steel rails has been an important problem for many years, and the new Kinney process involves quenching the rail while cooling from rolling heat, discontinuing the quench at a predetermined temperature, and finally subjecting the rail to controlled cooling. This "graded hardening" or "interrupted hardening" has been shown to be theoretically and practically sound and there are unquestionably many instances in present commercial heat treatment where the old quench and temper operations will be superseded by some form of "interrupted hardening."

One of the most recent developments in heat treating is that of heating by induction, and it is claimed that the method has been worked out on a production basis and operated successfully on crankshafts. By quenching with water at high pressure, after surface heating of the steel, a hard case is produced. (See *THE IRON AGE*, Oct 29, 1936.)

The more important developments in stainless and heat resisting steels are found in the various efforts to "stabilize" the 18 and 8

type of stainless alloys. Following the known effects of titanium in this direction, the work on the deactivation of carbon by columbium must be noted.

It is perhaps surprising that it was not until about 10 years after the publication of Adcock's work illustrating the profound effect of nitrogen on the structure and properties of iron-chromium alloys, that data were recently recorded to demonstrate how grain refinement and improved strength and toughness can be obtained by the addition of small amounts of nitrogen to low-carbon high-chromium irons.

#### Aging Heat Treating

The first phase, heat treatment of the complete section, may be broken down into a third and last subdivision entitled, aging heat-treating processes. The aging of steel at ordinary temperatures has been recognized for many years and many investigations have been conducted to overcome the resulting embrittling or magnetic hardening effects, as well as the strain-aging so frequently encountered in low-carbon steels. However in recent years aging has come to be recognized as a precipitation phenomenon and many alloys have been marketed which, by virtue of the controlled precipitation of a phase under clearly defined heat-treating conditions, exhibit partic-

ular physical and mechanical properties that are otherwise difficult to obtain.

Space will permit only limited reference to some of the newer developments.

Much has been written recently of the new high-strength low-alloy steels, and stress has been laid on the fact that for commercial applications that quality most desired is a marked increase of the yield point (or more strictly the elastic limit) of the alloy rather than an increase in the tensile strength. It would seem that many new low-cost alloys are likely to appear which depend, at least partly, on a precipitation hardening treatment for their enhanced mechanical properties. The profound effect of ordinary aging treatment on the elastic limit of carbon steels was demonstrated by Briggs in 1932. In a medium-carbon steel the yield point was increased from 50,000 to 70,000 lb. per sq. in. by aging for 30 days at room temperature after quenching from 680 deg. C. No serious loss of ductility was indicated. The importance of this phenomenon in low-alloy steels has already been appreciated as indicated by the introduction of the copper steels containing more than about 0.6 per cent copper. Thus, while about 0.25 per cent appears to give the optimum as regards resistance to atmospheric corrosion, considerable

increase in tensile strength is obtained after suitable heat treatment when 1.5 per cent copper is present. The greatest change in properties occurs when the precipitation hardening temperature lies between 430 and 540 deg. C. A steady decrease in the effect of precipitation hardening occurs with increase of carbon. However the increase in resistance to corrosion (particularly atmospheric) has been a predominating factor in the development of these low-alloy steels.

Reference may also be made to a report on the precipitation hardening of steel by the addition of a nickel-aluminum compound. From considerable experimental data, Foley suggests that this compound is soluble in austenite but not in alpha iron. Thus, on quenching a 5 per cent nickel-iron alloy containing 2.6 per cent aluminum from about 800 deg. C., a hardness of about 200 Brinell was obtained. The maximum effect on hardness by tempering was obtained at about 560 deg. C., when the hardness was increased to 360 Brinell. Similar hardening effects were recorded on a chrome-nickel-aluminum valve steel (0.5 per cent C, 1.6 Ni, 10.7 Cr, and 1.8 Al) after tempering at 540 deg. following the solution treatment. Of particular interest is the statement that nickel-chromium steels which are normally austenitic may have their hardness increased, when aluminum has been added to the alloy, by the precipitation of the nickel-aluminum compound. The age hardening of austenite by the addition of titanium was described a few years ago.

Recent progress in the production of new materials for permanent magnets is presumably due to an appreciation of the fact that the desired magnetic properties are in some way dependent on having alloy mixtures which will give rise to precipitation of a highly dispersed phase on suitable heat treatment. Thus it appears that the coercive force of a magnetic alloy is directly proportional to the surface area of a given disperse phase. Consequently permanent magnet materials after optimum heat treatment are very hard. Indeed the recent aluminum-nickel-iron alloys can be readily pulverized, and the powder mixed with a binder such as bakelite, for pressing into complicated shapes.

A maximum coercive force of about 550 oersteds can be obtained with this alloy, as compared with 75 oersteds for the well-known tungsten permanent magnet steel, or about 250 oersteds for the newer cobalt magnet steel. The correct heat treatment subsequent to casting is naturally necessary in order to obtain the optimum magnetic properties. Meshima states that annealing at 700 deg. C. stabilizes the structure and improves the remanence and coercive force of the nickel-aluminum-iron alloy.

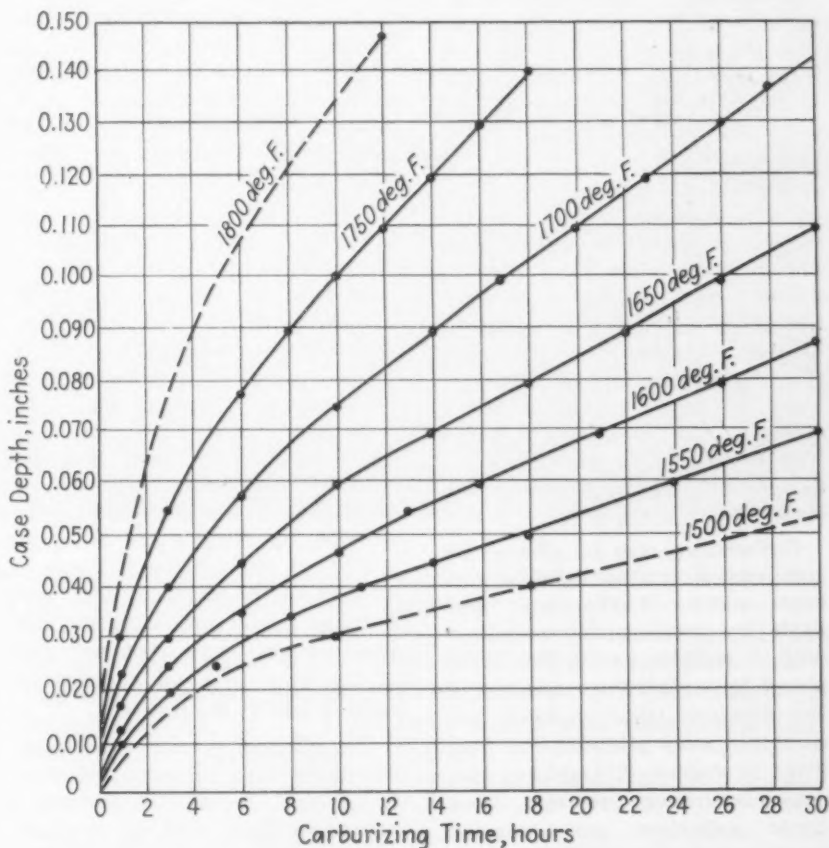
### Surface Heat Treatment

Of recent years considerable attention has been given to the surface treatment of metals and alloys whereby some particular physical characteristic might be imparted to the material in order that it might successfully withstand service conditions. Thus it is frequently true that the mechanical properties of a low cost steel are quite adequate for some required service, yet the alloy does not have the necessary resistance either to erosion by simple mechanical wear, to atmospheric or chemical cor-

rosion, or even to oxidation at slightly elevated temperatures. There appears little doubt that the future will see a profound increase in the utilization of the idea of surface treatment of metals in an effort to avoid the need of using expensive metals of high-alloy content.

Most surface treatments depend on two simple fundamental properties—solubility and diffusion. First, solubility of the element used to treat the surface is essential, and, secondly, the rate at which the surface coating is produced, as well as the commercial economics of the process, depends on diffusion.

Although fundamental studies on metallic diffusion may be said to have started with the early work of Roberts-Austen, before the start of the present century, relatively very little is known on the subject, particularly as regards the quantitative aspects of the phenomenon. Recent careful work on studies of the laws of gaseous diffusion, particularly by Smithells and his co-workers, is assisting in an under-



**R**EPRESENTATIVE curves showing the relation of time and temperature to carbon penetration. All carburizing done in vertical gas retorts using natural gas (95 to 98 per cent methane) as the carburizing agent. All measurements made on triangular test pieces. After R. W. Schlumpf.

standing of the mechanism of the process and particularly of the importance of a consideration of the metal surface at the gas-metal interface. In this connection the paper presented by Ham at the American Society for Metals convention in October merits attention. The recent science lecture by Mehl, presented before the American Institute of Mining and Metallurgical Engineers, gave a thorough and rather complete dissertation on our present knowledge of the subject of diffusion in metals.

So far as the practical aspects of the subject are concerned it is proposed to discuss briefly hereinafter the various methods of surface treatment which constitute commercial practice or appear to have commercial possibilities, and which may strictly be included in the general subject of heat treating.

#### Carburizing:

Despite the fact that carburization of steel is one of the oldest metallurgical arts, the subject demands the continued attention of investigators, and exact knowledge of the factors in successful surface carburization of steel is being accumulated. A particularly important example of the need for this information is typified by the uncertainty which still surrounds the production of "abnormality" in the carburizing process.

While surface carburization is usually associated with increased resistance to wear, account must also be taken of the fact that important improvement in mechanical properties may also result. In a similar manner it has been pointed out that surface decarburization of unmachined heat-treated steels, such as spring steel plates, may reduce the fatigue resistance to approximately half the intrinsic value of the material.

Carburizing may be effected by treatment with solid, liquid or gaseous media. Carburizing steel parts by packing in containers with a suitable carburizing compound is expensive on account of the time and labor involved. Accordingly much attention has been given to studies of liquid and gaseous carburizing processes. New liquid carburizers are appearing on the market which claim to introduce carbon in about one-third the time required for pack hardening.

In some industries, particularly the automotive, continuous gaseous carburizing appears to be finding increased favor. Two installations of this type are pictured in Fig. 4.

Many advantages have been claimed for gas carburizing, such as more rapid absorption of carbon at the steel surface, better control of carbon content in the case, and reduction in time of handling, both as regards loading and unloading as well as time saved in cooling from the carburizing temperature. Probably the matter of carbon distribution in the case will become increasingly important as the temperature of carburizing is raised on account of the more extensive use of steels which resist grain coarsening. Shutting off the carburizing gas some time before the end of the heating cycle permits the excess carbon in the hypereutectoid outer zone of the case to diffuse, thus reducing the brittle nature of this zone which has resulted from the very high carbon concentration in equilibrium with the gas at high carburizing temperatures.

Some interesting data on retort gas carburizing are shown by the work of R. W. Schlumpf, which clearly indicates the effect of time and temperature on carbon penetration in a natural gas atmosphere. These effects are shown graphically in Fig. 5.

In the Eutectrol process of continuous gas carburizing it is claimed that the units can be placed in the production line in the fabrication of steel parts, since the equipment can be built for a predetermined capacity which will synchronize with the speed and volume of output of any line. The furnaces, fired with city gas, are of the batch type and produce a 0.028-in. case on SAE 4620 steel at 1706 deg. F. in a 4½ hr. cycle, 1½ hr. of this time being required to heat to temperature. The carburizing gas is prepared from city gas in a gas preparation unit and is delivered with an addition of natural gas to the muffle.

The effect of special elements on the carburizing properties of steel has recently received considerable attention. Thus with up to about 3 per cent copper, carburization appears to proceed normally when the surface of the steel is free from oxidation. In studying the effects

of silicon, aluminum, manganese, nickel, copper, cobalt, chromium, molybdenum, tungsten, and titanium on carbon content and depth of case after case hardening in a solid carburizer, Houdremont divided these elements into two classifications; the carbide-forming elements which produce an increase in carbon content and the non-carbide-forming elements which reduce the amount of carbon absorbed.

Similarly it has been shown that silicon, manganese, chromium, nickel, and cobalt lower the rate of decarburizing of ferrous materials in a hydrogen atmosphere.

#### Cyaniding:

Where high wear resistance is desired, cyaniding of the surface of the steel is frequently resorted to. The latest type of cyanide furnace is also continuous in operation. A long cyanide pot is heated by gas or oil and over the pot there is arranged a worm-type conveyor which carries the work from one end of the pot to the other. Thus in this way it is possible to obtain a continuous production of uniformly cyanided parts such as gears.

#### Nitriding:

In discussing the present state of nitriding technique, Giolitti finds that 90 per cent of present applications for nitrided steel can be covered by two types of chrome-molybdenum-aluminum steels differing essentially only in aluminum content. These steels have the approximate composition 0.2 to 0.55 per cent C, 1.4 to 2.0 Cr, 0.15 to 0.35 Mo and either 0.3 to 0.4 or 1.0 to 1.2 per cent Al. Nickel should be kept under 0.2 per cent.

Steels of the higher aluminum content have 1200 Vickers hardness while the low-aluminum alloys give a nitrided hardness of 900 to 1000 Vickers. The well-known increased resistance to wear, compared with carburized steel, is discussed as well as the fact that nitrided steels are free from deformation and strains.

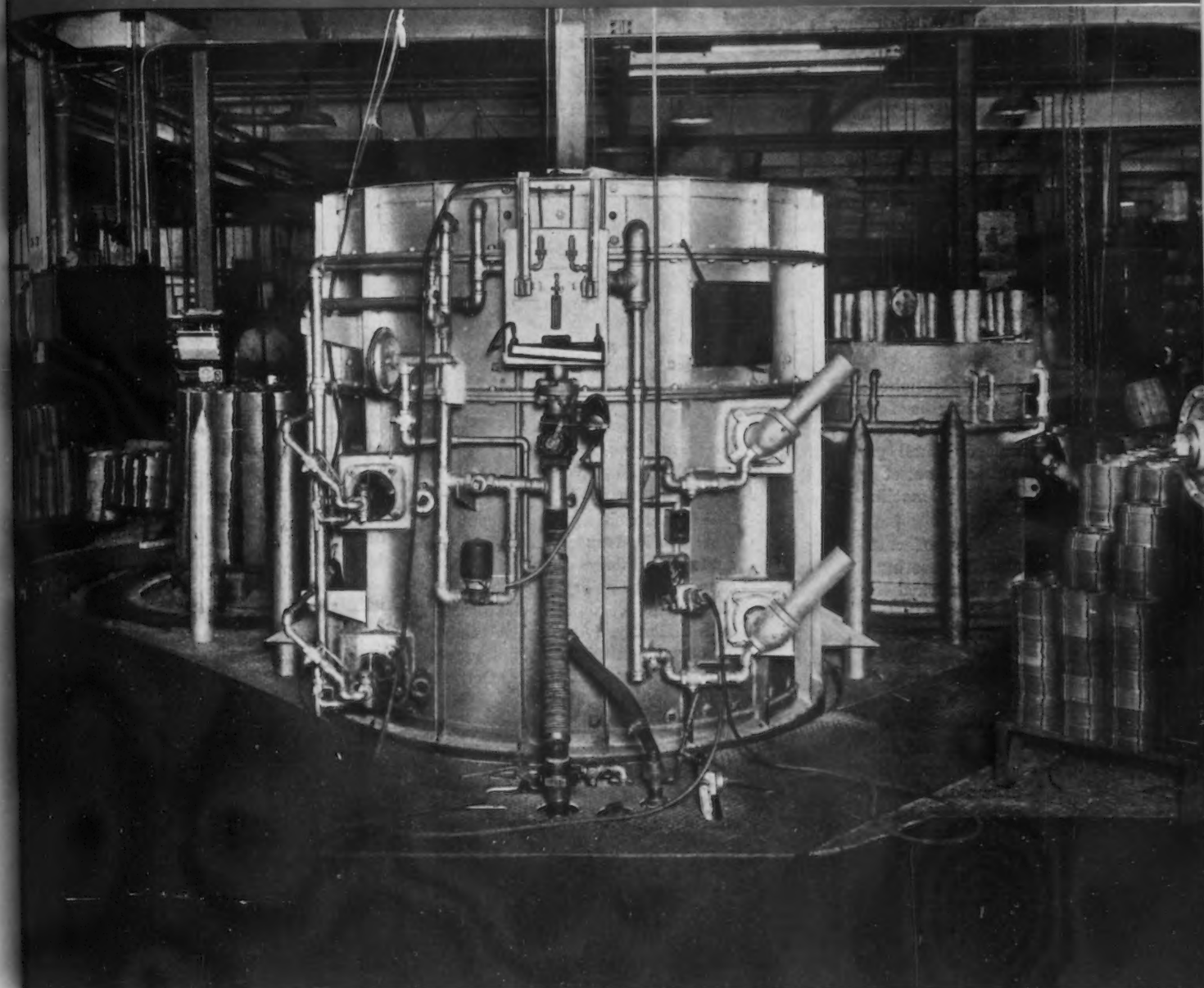
When impact resistance is required the aluminum should be cut down to 0.1 to 0.15 per cent, the chromium raised to 2.6 per cent and molybdenum to 0.45 per cent, and about 0.27 per cent vanadium added.

Apparently no marked success

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has attended the attempts to shorten the nitriding cycle such as through the use of super-sonic high frequencies.

Protective coatings for selective nitriding continue to receive attention. Electrolytic plating with tin appears to give the most positive and well defined protective coating for those surface parts which should not take the nitride hardening effect. Acidulated solutions of stannous chloride or sodium stannate as well as alkaline sodium stannate have been recommended for producing the electrolytic coating of tin. The parts to be nitrided, which of course must be free from tin, are protected from the tinning action by coating with a resinous varnish. Where absolute protection from nitriding is not required a paste containing finely pulverized lead and tin may be used.

An important application of selective nitriding is found in the treatment of cylinders for pneumatic tools or small gas engines, where inlet and outlet parts must be finished by machining after hardening.

The nitriding of cast iron now appears to be meeting with success, and the marked resistance to wear and to certain types of corrosion of nitrided materials suggests the use of cast iron, so treated, for such purposes as cylinder sleeves in motors, used in the heavy automotive industry where cost of overhaul and hence the tying up of equipment is considerable. Various data have been published on the special grade of iron known as Nitricastiron when used as cylinder sleeves in the operation of combustion engines. The marked increase in service life in terms of mileage in both stationary engine tests and in road tests is at once evident.

Centrifugally cast liners are now being used for this purpose since a much sounder product is obtained with freedom from the aluminum oxide scum which frequently becomes entrapped on the surface in sand casting of Nitricastiron. Such surface defects would naturally result in the production of soft spots on subsequent nitriding. Some authorities consider that only cast iron which has been centrifugally cast can be nitrided satisfactorily.

One investigator states that for

the production of a uniformly hard and even nitrided layer the cast iron must be free from coarse graphite flakes and ferrite spots, and efforts were made to obtain this surface by malleabilising white iron. Experiments showed that iron with 2.7 per cent C, 0.25 per cent Si, 0.87 per cent Al, and 1 per cent Cr was suitable; it graphitized on annealing at 1832 deg. F. for 8 hr. and any ferrite formed could be converted into fine pearlite (sorbite) by oil-quenching from 1652 deg. F. On nitriding, the surface was perfectly smooth, and it was stated that increased surface toughness could be obtained by small additions of nickel.

In studies of the nitriding of austenitic manganese, chromium and nickel steels, a surface hardness of 1000 Vickers was obtained in a steel of 18½ per cent Mn and 0.15 per cent C after 48 hr. at 1040 deg. F. A nickel steel (35 per cent Ni) could not be hardened under these conditions and a nickel-manganese steel (14½ per cent Ni and 5 per cent Mn) did not harden appreciably.

A martensitic, 13 per cent Cr steel nitrided successfully but the surface hardness was greater if copper plated prior to nitriding. The high nickel chrome steels nitrided with difficulty. (A complete résumé of current nitriding practice appeared in *THE IRON AGE*, Oct. 15, 1936.)

#### Flame Hardening:

Local hardening by impingement of a hot flame on the surface of steel to be hardened, as in gear hardening applications, followed by some form of quench has been employed for some years, but the new Shorter process substitutes mechanized control of the former hand operated acetylene torch. The speed of the flame over the work to be hardened is mechanically controlled, and the heated part is quenched by an air or water spray immediately following the heating process. Apparently correct co-ordination of the heating and quenching operation depends on experimentation for each of the problems considered. (See *THE IRON AGE*, Aug. 8, 1935.)

It is reported that many commercial products, where increased resistance to wear is desired, have been satisfactorily treated in this way. Studies by Zorn on auto-

genous surface hardening indicate that 0.4 to 0.6 per cent is the most suitable carbon range for this treatment. He found that with more than 1 per cent Mn the steel must be handled with care so as to effect less drastic quenching. Presumably the higher manganese steels can be treated without difficulty so long as the carbon content is reduced. It is also reported that from 2 to 5 per cent Ni increased resistance to wear but has practically no effect on the hardenability of the steel. With more than 1 per cent Cr, fissures tend to appear on the heat-treated surface unless it has been subjected to preheating.

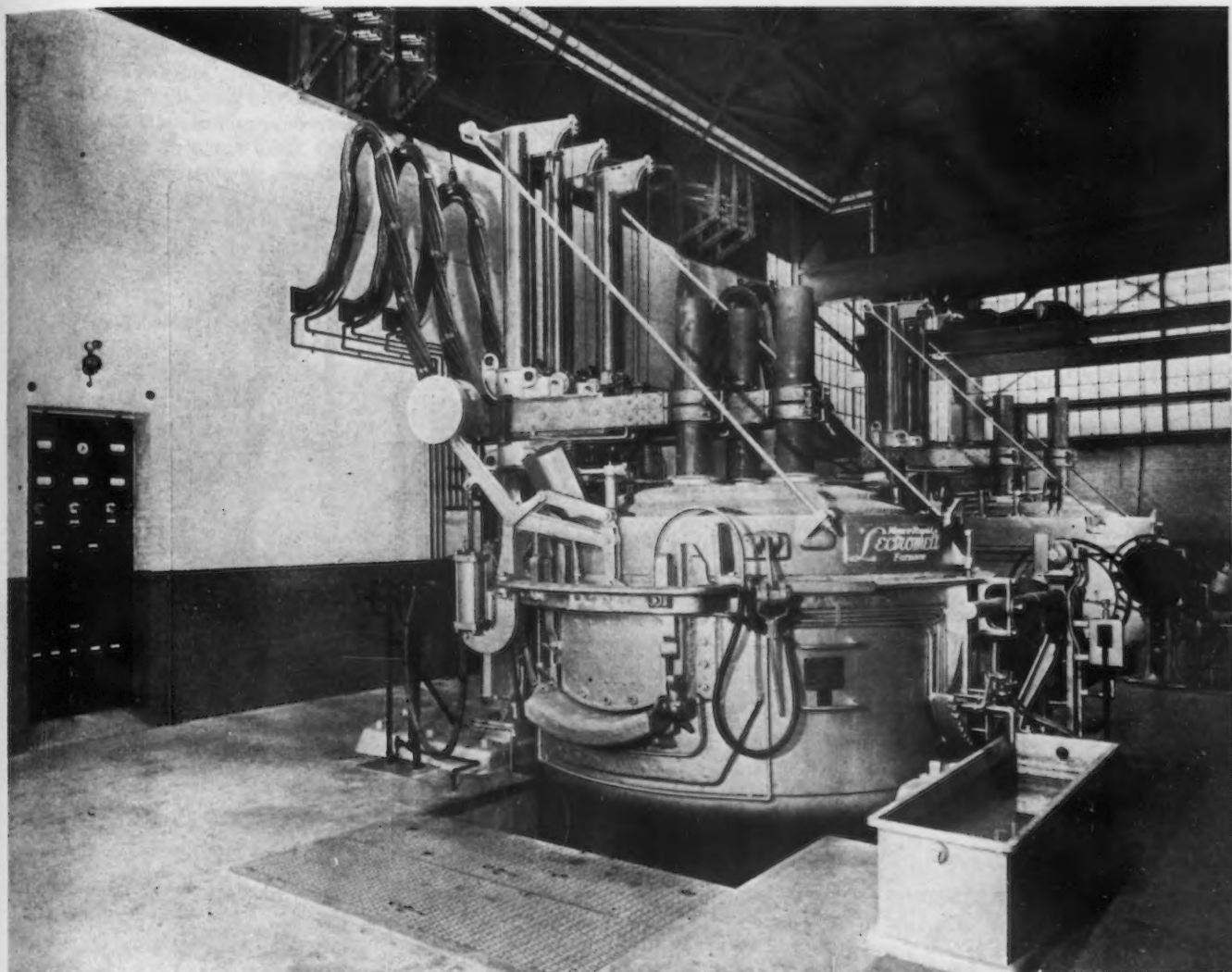
Practical use of local surface hardening has been made in its application to crankshafts. For this purpose tests were made to determine the relation between rate of heating and depth of hardening, as well as the structure obtained. In this surface hardening study the hardened layer was considered to be adequately thick, the core remained unaltered and the process involved but a short time. The process has also been applied to ordinary cast irons, where the hardness of the machined surface was raised from 220 to 460 Brinell with a total depth of the surface hardening effect of 1/16 in.

#### Methods Involving Metallic Solubility:

Of the well-known and important diffusion methods of surface hardening already briefly discussed, each deals with the effects of gaseous diffusion or of the diffusion of non-metallic elements. Appreciation of the importance of corrosion or corrosive effects on the reduced service life of many alloys has lead to much study of the economic preparation of low cost alloys of adequate mechanical strength with a surface which imparts the property of resistance to various types of corrosion found only in the expensive special high-alloy content materials.

CALORIZING is one of the best known of these treatments. The steel is usually sealed in a retort containing the calorizing mixture (various mixtures containing aluminum are used) and heated to above the higher critical temperature for several hours. The process is essentially one of driving aluminum into the surface layer of the steel to form an iron-alumi-

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num alloy. Upon subjecting to heat a very thin tightly adherent film of aluminum oxide is formed on the surface of the metal. This offers complete protection from oxidation of the underlying steel surface, and it is claimed that the steel is thus immune to atmospheric corrosion up to 1652 deg. F. Naturally there are numerous applications in which such processed steel may be used but the importance of calorizing in increasing the resistance of carbon steels to creep at elevated temperatures may be particularly noted. Thus many inexpensive steels are satisfactory for certain high temperature service so far as their mechanical properties are concerned, but service life is short due to the more important corrosive influences. Very recently it has been demonstrated that carbon steels which appeared to have all the necessary resistance to plastic flow for the required purpose suddenly failed due to intergranular oxidation. While the creep characteristics could be deduced from several hundred hours of test, several thousand hours were necessary to reveal the effect of penetration of the atmospheric corroding influence on the surface. Apparently calorizing tends to inhibit this effect. At higher temperatures the heat resisting steels frequently be-

come necessary for satisfactory service on account of the greater intrinsic strength at elevated temperatures above 932 to 1112 deg. F.

IHRIGIZING refers to the impregnation of the surface of steel with silicon in order to increase resistance to corrosion, heat and wear. The steel is heated to above the upper critical temperature in a high silicon content material using an energizer to facilitate the reaction as in ordinary pack carburizing. The steel may then be heat treated without any apparent effect on the core. It is claimed that Ihrigized surfaces will withstand boiling in 10 per cent sulphuric acid for over 100 hr. Presumably they are particularly resistant to most types of oxidizing agents. The case contains about 14 per cent silicon and can be cut with a hacksaw since the hardness is about 160 Brinell.

Finally, reference will be made to some of the less well developed cementation processes.

On account of the important role of chromium in the manufacture of stainless and heat-resisting ferrous alloys it is natural that some thought be given to the production of a high chromium content surface on ordinary carbon steels. Hicks, by means of an X-ray study of the diffusion of chromium into iron, obtained a concentration-

depth curve after heating for 96 hr. at 2192 deg. F. The concentration fell off gradually from about 65 per cent Cr at the surface to about 15 per cent at a depth of 0.036 in. where it dropped abruptly to almost 0 per cent. Photomicrographs were presented by the investigator which clearly illustrated this latter point. More recent work describes the heating of bars in powdered chromium at 2399 deg. F. for the purpose of making chromizing commercially feasible for imparting corrosion and heat-resisting properties to steel surfaces. It is recommended that the depth of case be about  $4\frac{1}{2}$  per cent of the diameter of the bar. Coated material which is estimated to cost about 4c. per lb. of steel may be rolled into various forms.

Despite the present high cost of beryllium, information on the cementation of steel by that metal merits attention on account of the extremely hard alloy that can result from iron-beryllium alloys of suitable composition. After cementation, electrolytic iron, steels of various carbon content and cast iron were very resistant to corrosion by water, sea-water, salt spray and by weathering conditions. Corrosion under chemical attack by chlorine water and particularly by nitric acid was much reduced. A surface hardness of "1500 Brinell" was obtained on the eutectoid steel and on the cast iron.

Studies have also been conducted on the cementation of iron, nickel and copper at various temperatures by use of powdered ferro-titanium. It was found that titanium diffuses into these metals at a temperature higher than 1472 deg. F., the rate of diffusion increasing with rise in temperature. In the case of iron the diffusion rate increased abruptly at the upper critical point. The law governing the depth of penetration was found to be the usual exponential function of diffusion with respect to time or temperature. Although the cemented surfaces are harder, they are little more resistant to corrosion.

Experiments on the diffusion of carbon, silicon and manganese into iron between 1652 deg. F. and 2282 deg. F. have showed, as might be anticipated, that the element manganese migrates more slowly than carbon.

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# WELDING AND FABRICATING

*Substantial increase in equipment sales reflects wider acceptance of welding and cutting. Machine and process developments make for improved quality and lower cost.*

By RALPH MILLER

---



MORE extensive use of welding and cutting during the past 12 months is definitely indicated by a number of factors, the most immediate of which is the considerably increased volume of business enjoyed by the makers of equipment and supplies. However, in addition to the greater demand occasioned by accelerated general industrial activity, there have been other factors, such as the broader acceptance of cutting and welding by regulatory bodies in codes and specifications, as the result of research; better understanding of the application of welding on the part of designers; and comprehensive metallurgical study and acceptance. Process and equipment improvements have also contributed.

Further recognition of fusion welding by regulatory bodies includes the recent experimental ap-

proval of the process by the Interstate Commerce Commission for tank car construction. With the publication of the A.S.A. code for pressure piping, fusion welding is recognized for the joining of all classes of steel piping irrespective of pressure or temperature.

Revisions in the boiler repair rules issued last year by the authority of the National Board of Boiler and Pressure Vessel inspectors definitely recognize fusion welding for this type of repair. Acknowledgment of the suitability of welding and cutting as tools for the construction and repair of bridges has resulted from work by the American Welding Society, whose specifications for the design, construction, alteration and repair of highway and railroad bridges by fusion welding is regarded as marking another step in the use of welding in the structural field.

For assisting designers of ma-

chines and structures, authentic test data covering fundamental factors governing weld design have been made available both by makers of welding and cutting equipment and by welding societies. These data cover methods of calculating weld stresses and working stresses for different types of joints, stress concentration, distortion and other design problems.

Increased attention has been given to the metallurgical behavior of the metal in and about the weld. Marked progress has been made in the welding of alloy materials, and authoritative data relating to the welding of practically the entire range of commercial metals are now available.

In addition to widening application there have been a number of substantial equipment and process improvements. Many of these, grouped into their respective types—oxy-acetylene, electric arc and electric resistance, are outlined below. Innovations in the welding field in the past year included the Longoria process in which high frequency electrical energy is said to break down the molecular bond of the metals to be welded, resulting in the joining of two strips of metal at a temperature much lower than with the usual welding processes.

## Oxy-Acetylene Cutting and Welding

FURTHER refinement in processes and equipment, with a widening of application again featured the oxy-acetylene welding

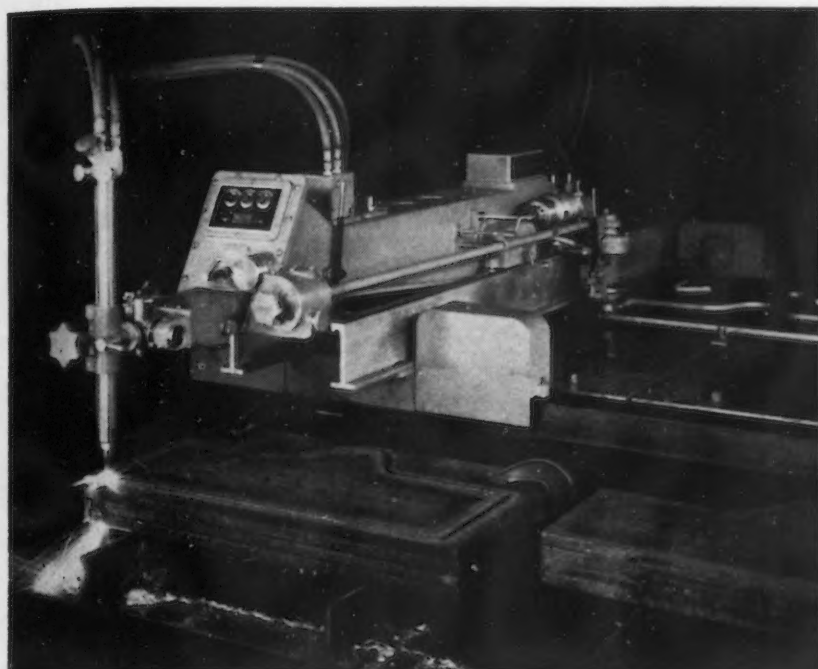
and cutting field. In pipe welding, extended use of multi-flame welding, which provides increased speed and lower gas consumption per

sions and icicles, and seals the opening of the vee so that the thermal energy of the welding gases is utilized more economically

soft and bulbous type flame, adjusted to assure a neutral welding atmosphere, is employed.

Although not as much publicized as production applications, use of the oxy-acetylene processes in the vast field of reclamation and repair has been considerably extended. In this direction it is felt that greater progress with increased savings would be made if engineers at large looked upon repair welding and cutting in the same light as production applications. "The day has passed when even the repair job should be turned over to the welder without first having been given consideration by the engineer from the standpoint of procedure control factors involved," states a recent report of the International Acetylene Association.

Fusion welding, hard surfacing and bronze welding all take important parts in reclamation and repair work. Use of bronze welding has increased in repairing broken machinery as well as in the rebuilding of worn parts, the latter especially in automotive repair work. Bronze facing of Monel metal has proved useful, one interesting recent application being the

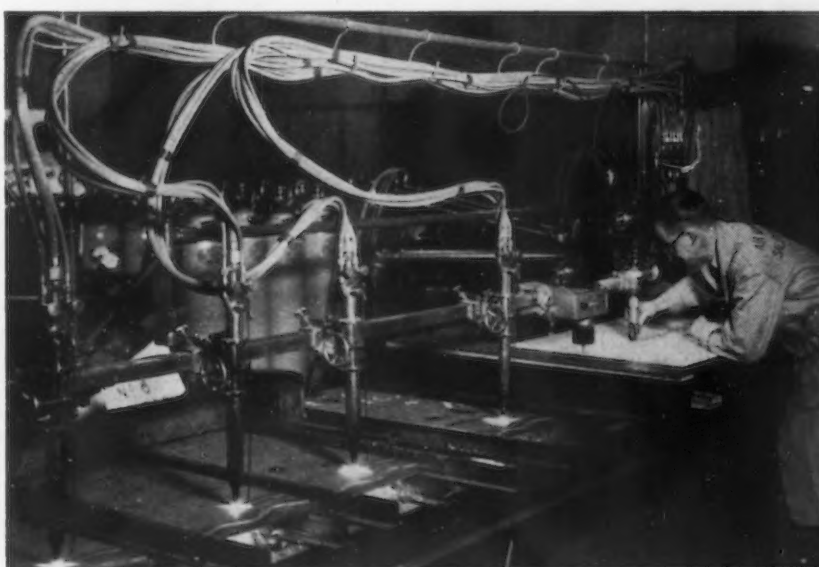


**E**CONOMY of simultaneous cutting of a multiplicity of parts from several layers of plates stacked together has gained wider recognition. The machine here pictured is the new type CM-12 shape cutting unit of the Linde Air Products Co.

joint, is reported. Overland pipe construction has been especially active and in this field the "stove-pipe" method of construction has attracted attention. In building and in industrial piping, increased use of gas welding and brazing is attributed in part to wider availability of fittings especially produced for welding.

#### Multi-Layer Pipe Welding

For high pressure and high temperature service requiring heavy wall pipe, a long-step method of multi-layer oxy-acetylene welding has been developed by the Air Reduction Sales Co. The method is applicable to both rolling and position welds, and advantages in ductility and impact value of the weld metal are claimed, as well as reduction in welding time, and in filler rod and gas consumption. Improvement in weld metal ductility with little sacrifice of tensile strength is attributed to grain refinement resulting from the welding heat of the two or more successive layers of weld metal. The first layer seals the bottom of the vee from cold shuts, slag inclu-



**A**NOTHER production application of flame cutting. Four parts are produced simultaneously for one drawing, movement of the torches being controlled by a motor-driven tracing device. This machine is the No. 6 Oxygraph built by the Air Reduction Sales Co.

in depositing further layers of weld metal. Each layer, except the final one, is deposited with a flat or concave upper surface rather than with the usual convex surface. A

rebuilding to original size of worn Monel metal covers of washing machines.

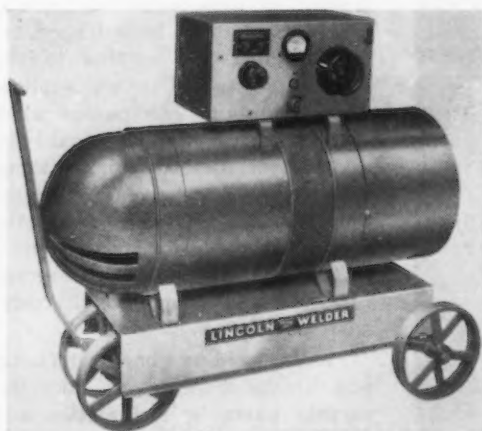
Apparatus developments during 1936 included a number of further

refinements in flame cutting. A wide variety of machines for production operations, ranging from the simple beveling of steel plates to the cutting and shaping of intricate shapes in three dimensions, is now available. For many purposes the cut pieces can be used

rection, is limited only by the accuracy of a motivating device requiring only sufficient power to move the weight of the blowpipe itself."

Stack flame cutting, in which several layers of plates are stacked together and from them a mul-

Air Products Co., featuring increased power and cutting capacity. Shapes of all descriptions can be cut. Automatic straight line cuts up to 144 in. in length may be made parallel to the length of the machine without templets or hand guiding and similar cuts up to 51 in. may be made at right angles. A feature is the ability of the machine to make automatic straight line cuts at any desired angle in the horizontal plane. A special attachment permits automatic cutting of circles up to 48 in. in diameter. Speed range is from 1½ to 75 in. per min. Positioning scales permit inclining the



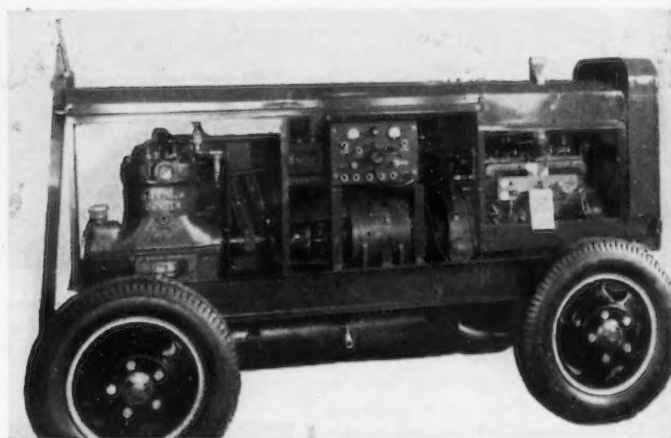
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**D**UAL continuous control which permits adjustment of both arc heat and penetration in a continuous series of fine increments, features this new Lincoln "Shield-Arc SAE" welder.

without further machining. Acceptance of oxy-acetylene cutting in the pressure vessel codes of the A.S.M.E. and the A.P.I. for shaping of steel parts and plate edges of steel up to 0.35 per cent carbon content presages, perhaps, a general acceptance of the process for similar material irrespective of use.

A number of flame cutting procedures have been developed. These include not only the cutting of low-carbon steels, but of stainless steels, cast iron and of oxygen lance cutting. The latter, used for many years in the iron and steel industry for opening furnace tap holes, for cutting up spills and skulls, etc., is being employed increasingly in other industries.

The flexibility, speed and economy of modern flame cutting have been long appreciated, but the accuracy has not been so widely recognized. In commenting upon this feature of the modern flame cutting machine with mechanically-guided blowpipe or torch, the report of the International Acetylene Association states: "There is every reason that it should be so considered [definitely a precision tool]. There is no contact between the work and the tool except the oxy-acetylene preheating flames and the oxygen stream. As a consequence there is no friction and no vibration. The accuracy of the cut, therefore, when advanced at the proper speed and in the proper di-



#### ABOVE

**T**HIS 300-amp. gas-engine driven Dualarc welder built by the Electric Arc Cutting & Welding Co., is equipped with a 1000 cu. ft. compressor to supply compressed air for hammer annealing or peening and caulking.

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#### AT RIGHT

**A** DEPARTURE in arc welding, this low-range d.c. welder announced by the General Electric Co., utilizes rectifier tubes instead of rotating equipment.

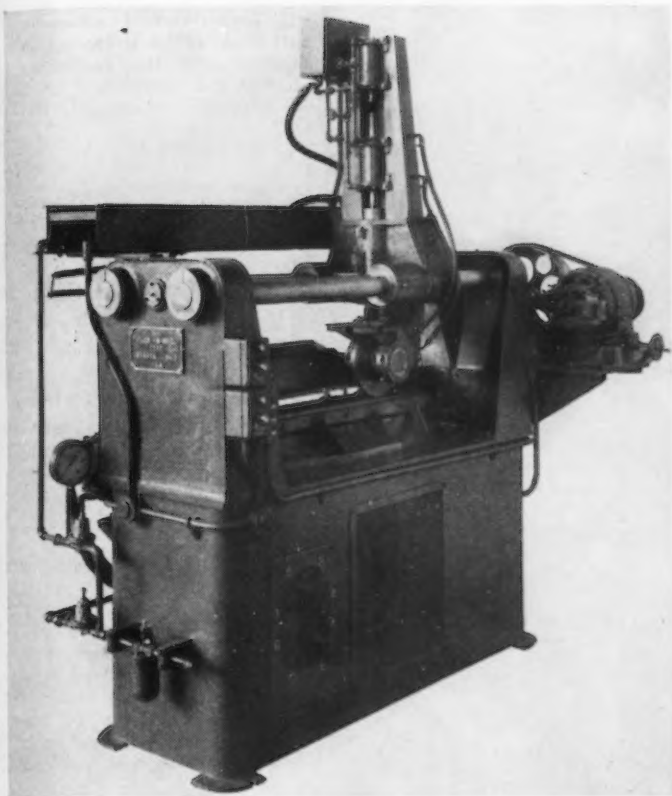


tiplicity of parts turned out at the same time, has gained much wider use.

#### New Shape Cutting Machines

Shape cutting machines brought out during the year include the Oxweld type CM-12, by the Linde

blowpipe or torch at any angle up to 90 deg. in either of two directions or in two directions simultaneously. An improved blowpipe is provided. Alloys are used extensively in the construction of the machine to provide stability and rigidity; precision cutting is said



ABOVE

**A**IR-OPERATED, traveling-head roll automatic seam welder built by the Taylor-Winfield Corp. for continuous strip mill application. Capacity is for material up to 38 in. wide. On 24 gage stock operation is 40 ft. per min.; on 16 gage stock, 8 ft. per min.

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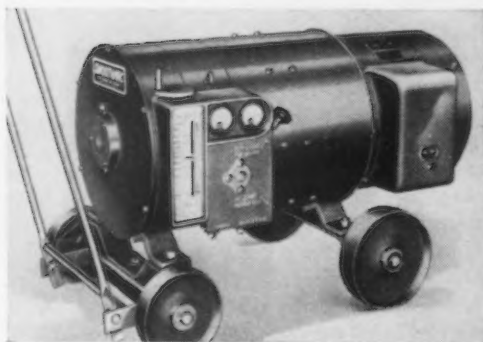
further to be assured by freedom from friction and vibration, sensitive tracing mechanism and accurate transference of motion. Operating controls are provided at both cutting and tracing positions. The machine is designed to carry from two to five blowpipes for multiple cutting.

A new automatic shape cutting machine, the Geweco style K-P, was bought out by the General Welding & Equipment Co., Cambridge, Mass. This equipment is portable, the machine itself weighing only 135 lb. and the separate track system, 95 lb. It is designed for shape, circle and straight cutting from strip aluminum templets and from blueprints or rough sketches. Cuts are clean and accurate and need little if any machining. The cutting area is entirely outside of the machine. The rectangular cutting range is 30 in. by 5 ft. and circles from 1½ to 30 in. in diameter. The machine can be equipped with two

torches. It is built largely of aluminum, has a floating tracing mechanism, and all bearings are of anti-friction type.

#### Torches and Regulators

New developments in hand torches included a unit featuring lever control and gas-saver shut-off in the handle, resulting in the elimination of waste gases. Application or release of natural thumb pressure on the control lever in the handle produces full preadjusted welding flame or reduces the flame to pilot light size, respectively. This is a development

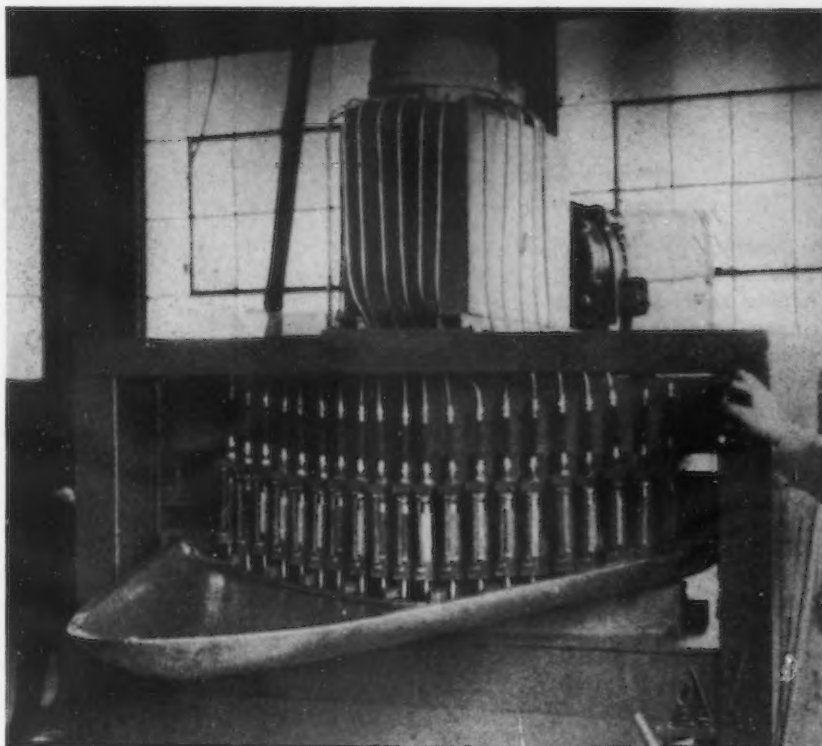


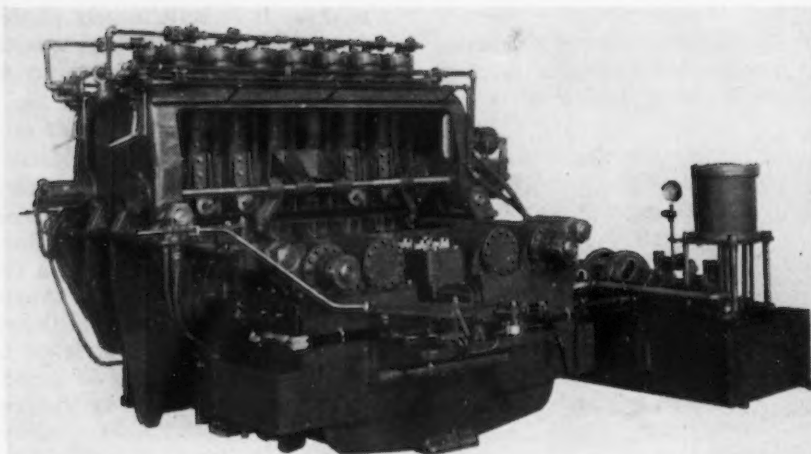
BELOW

**R**OTH Hydromatic for welding hood panels. This new unit incorporates a controlling device which automatically adjusts welding time, as well as the successive speed of the welds, according to metal thickness. Simplicity of construction, with few moving parts, is a feature.

ABOVE

**S**INGLE current control, self-excitation and internal stabilization feature this "Smootharc" welder, introduced by the Harnischfeger Corp. during the year. Vertical as well as horizontal mountings are available.





**T**HIS Taylor-Winfield automatic butt flash welder is for use in connection with the continuous production of cold strip up to 84-in. wide. Hydraulic clamping is employed.

o o o

underneath the rail, permitting the rail to fall in place in the center of the existing track, from which position it was lined over to gage after the existing rail had been removed. No difficulty was experienced in transporting the long

of the Weldit Acetylene Co., Detroit.

Two new oxygen regulators and a new acetylene regulator of unusual working range were added to the line of the Linde Air Products Co. All are of two-stage construction and are identical in design, with most parts interchangeable. One oxygen regulator, the R 64, is for general duty and has capacity for working pressures up to 75 lb. per sq. in.; the other, the R 65, is for operations requiring pressures above 75 lb. Sturdy construction, with use of modern materials and precision machining, are emphasized, as well as features such as coloring of dial faces—green for oxygen and red for acetylene—for operating convenience and safety.

The same company introduced two improved Carbic portable acetylene generators—one a low pressure and the other a medium pressure unit.

#### Long Length Rails Made by Thermit Pressure Welding

Outstanding new applications of Thermit welding continue to be in joining railroad rails in long continuous stretches. A recent application was the thermit pressure welding by the Northern Pacific Railroad of continuous rails for two 4000 ft. tunnels in Montana, one near Livingston and the other near Helena. As lack of room prevented welding operations within the tunnels, the work was done on top of a continuous train of 110 open end flat cars, on which the rails were welded together in 4000 ft. lengths. The train was then transported to the tunnels, split in the center and each half drawn in opposite directions from



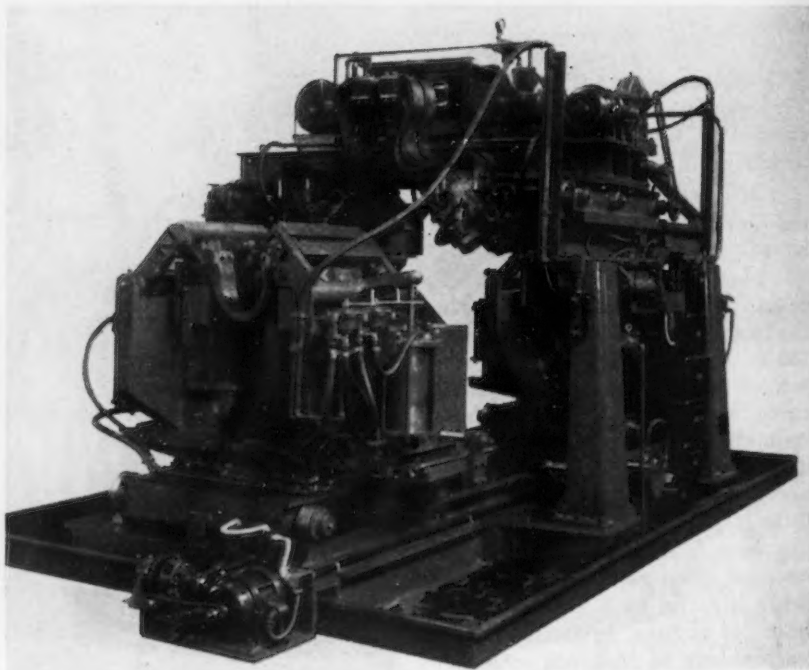
AT LEFT

**S**WIFT 100-kva. portable gun welding outfit. Transformer, contactor panel and timer, as well as necessary valves and switches, are inclosed in a truck-mounted cast housing. The guns on top of the housing are air-operated, single-acting spot welders.

o o o

BELOW

**F**EDERAL traveling-head roller seam welder for high production welding of two joints simultaneously in making liners for refrigerator cabinets and other box-shaped sheet metal units. Two fixtures are track mounted on the base, one is loaded while work in the other is being welded. More than 5400 in. of welding is done in an hour.



# rivet or weld

CHAMPION SERVES BOTH — BEST

*Accumulator* — Welded with Champion RED DEVIL electrodes, tested at 2800 lbs p. s. i.



*Princess Anne* — Modern design demands the use of dependable Champion VICTOR Ship Rivets

*Triborough Bridge* — Champion VICTOR Rivets used throughout, accuracy in workmanship was paramount



*Hiawatha* — VICTOR Boiler Rivets are a guaranteed product in the construction of a modern steam locomotive

Styles and sizes change but wherever metal joins metal there is a Champion product to make the union durable and permanent. This has been true for over forty years . . . first, the rivet, steadily improved to meet the ever increasing demands for better design and workmanship, permitting higher working pressures in boilers and greater

load requirements in the structural members. Welding has brought about a new art in the joining of metals. We, in keeping with progress, foresaw this development over five years ago, and accordingly placed on the market a complete line of shielded arc electrodes which have set up new quality standards.

*Insist upon either Champion Victor Rivets, or Champion Red Devil, Blue Devil and Gray Devil Electrodes*



**THE CHAMPION RIVET COMPANY**  
CLEVELAND, OHIO . . . . . EAST CHICAGO, INDIANA

welded lengths even when negotiating grades and curves.

## Developments in Arc Welding

A LARGE increase in demand for machines and electrodes has featured the arc welding equipment field. Although there has been a steady widening of new application, the increased demand has no doubt been due in some degree to replacements made necessary by the marked improvements in equipment over the past

Shield-Arc S.A.E. welder brought out by the Lincoln Electric Co., Cleveland, and featuring dual continuous control. The system provides for continuous adjustment of open circuit voltage and welding current. It replaces the former four-step switch arrangement and permits adjustment of both arc heat and penetration in a continuous series of fine increments. The machine is compact, has increased capacity, and is easy to operate. Optional equipment includes remote control.

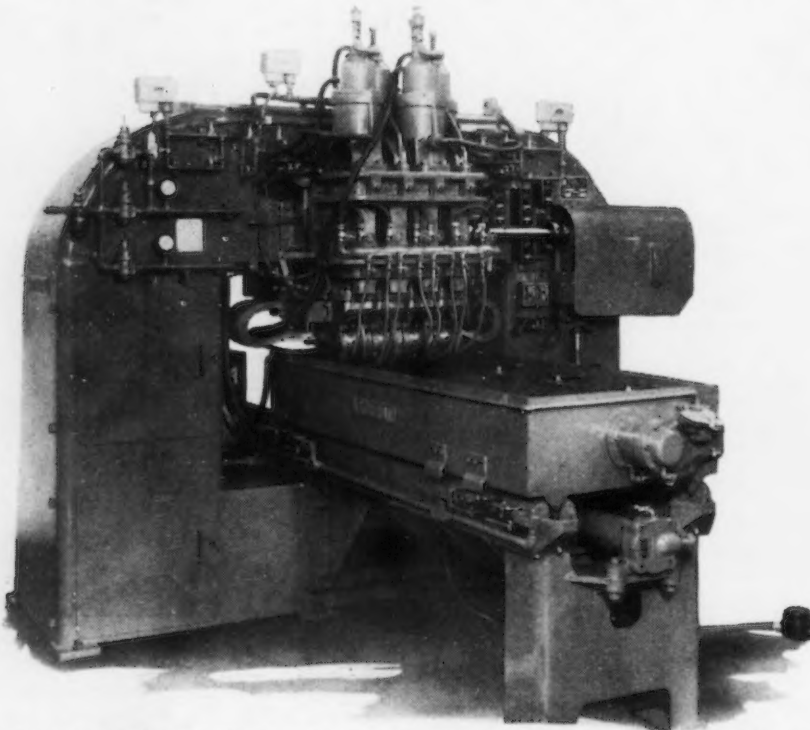
A new general utility, 45 to 200-amp. arc welder designated as the SA-150 was introduced by the

a low ranged d.c. welder utilizing rectifier tubes instead of rotating equipment. This equipment, recently introduced by the General Electric Co., uses four mercury Tungar tubes and is designed to operate on three-phase, 50 or 60-cycle power, 230,440 or 550 volts. It has a current range of 25 to 75 amp. controlled through a nine-point tap switch. It is mounted on hard rubber casters and weighs 140 lb. Uses include welding of light gage car or truck parts, and fabrication of roofs, ceilings, steel cabinets, steam fittings and the like.

Featuring "selective motor horsepower control," the serial MN model recently added to the line of the Hobart Brothers Co., Troy, Ohio, is credited with being the first arc welding set equipped with economical control of the motor as well as the generator. Reduction in welding current costs by 30 to 50 per cent on average work, avoidance of power company penalties due to poor power factor, elimination of expensive rewiring in many plants, and reduction of idling and light load power by one-half are claimed. Operation is simple. A convenient latch locks the handle in the "low" position, where only one-half the rated motor horsepower is used for starting and for welding up to one-half the rated generator capacity in continuous manual arc welding. An improved type of wheel mounting with low center of gravity is also a feature. This "serial MN current saving model" is available in six sizes, from 75 amp., 1½ to 3 hp. to 600 amp., 20 to 40 hp.

Noel "Speedarc" welders, with high power factor, high efficiency and high speed, were brought out by the Ideal Electric & Mfg. Co., Mansfield, Ohio. Unity power factor at full load and leading power factors up to 40 per cent at no-load are attributed to the special separately excited revolving armature type synchronous motor built into the machine. Rapid recovery from short circuit to normal welding current eliminates the necessity of frequently restriking the arc. Constant settings is another feature emphasized, the machine maintaining its current and voltage settings when started up cold and run full load for any period desired.

A new 150-amp. arc welder added to the P & H-Hansen line



**FULLY-AUTOMATIC** dual-transformer, four-roll series line welder developed by the National Electric Welding Machines Co. for seam welding of refrigerator condenser plates. It is equipped with a hydraulically traveled work-holder carriage. The 20 line welds between corrugations in the flat condenser plates are made in five table strokes. Welding speed is about 100 in. per min.

five years. Present machines are far better adapted to use of heavily coated electrodes as well as to light gage welding, and their improved design has not only provided better welding characteristics, but higher efficiency, greater convenience and lower operating costs. In direct current equipment, manual and single operator sets predominate, and demand has been for the most part for 300 amp. and smaller units.

A number of new machines, including two or more new automatic welders, have been introduced. Prominent among these is the

same company. Features include class B (non-inflammable) insulation, which permits operation at sustained peak loads without danger of burn outs. This machine occupies space of less than 2 ft. sq. and is offered for general fabrication with various metals, for repair work, for welding of sheet metal, and for fit-up and assembly welding in production welding shops.

### D. C. Welder Utilizes Rectifier Tubes

Another interesting development, and a departure in arc welding, is



## STRENGTH TO SPARE *and then some*

Pinion stands and mill drives made by the Farrell-Birmingham Company, Ansonia, Conn., are of all-welded construction. Some combine steel castings with rolled steel; others are fabricated entirely of flame-cut plates.

In operation, such equipment is subject to terrific shock and vibration. To withstand this punishment, the welds must be flawless and of highest quality. Because they can be counted on to produce such welds consistently, Murex Electrodes are employed. Not content, however, with the ample strength of the weld metal deposited by mild steel electrodes, Farrell-Birmingham builds an added five to ten thousand pounds tensile strength into the welds through the exclusive use of Murex Carbon-Molybdenum electrodes.

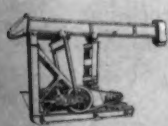
Wherever extra strength, absolute soundness or especially clean, smooth welds are required, Murex can be counted on to fill the bill. The heavy, all-mineral Murex coating reduces spatter and prevents undercutting. At the same time, by providing full protection of both arc and molten weld metal, it assures sound deposits of highest quality and promotes economy by permitting the use of higher currents.

Let us send you a copy of the Murex booklet. Metal & Thermit Corporation, 120 Broadway, New York. Albany, Chicago, Pittsburgh, So. San Francisco, Toronto.



# MUREX

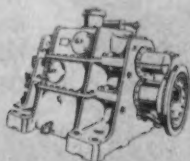
• • • • HEAVY COATED ELECTRODES



Oil Well  
Pumps



Power  
Shovels



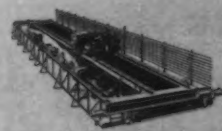
Steel Mill  
Equipment



Machine  
Tools



Railroad Equipment

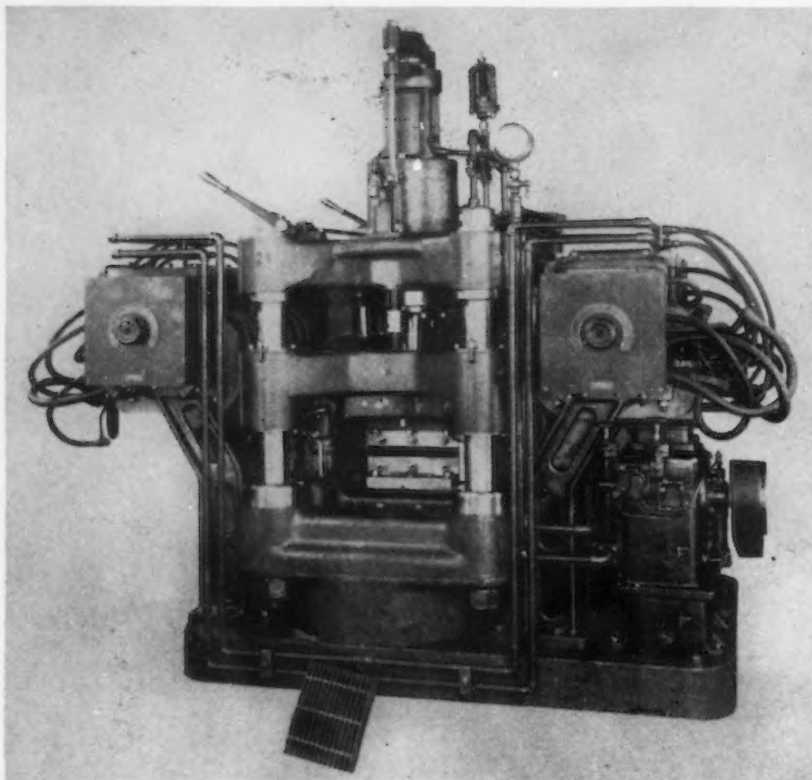


Cranes



High Pressure  
Piping

ING MAKERS WELD THESE PRODUCTS WITH MUREX FOR QUALITY AND ECONOMY



**M**ULTIPLE projection welding press built by Thomson-Gibb for mash welding heavy steel gratings and designed along the lines of a four-post hydraulic press. It is equipped with four 175 kva. transformers and the switches for making and breaking the circuit are operated through movement of the ram.

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of the Harnischfeger Corp., Milwaukee, features high electrical efficiency developed with the small air-cooled gasoline engine which powers it. Welding is said to be simplified through single current control accomplished by shifting brush holders for current settings over the entire welding range. For field service, the unit can be mounted on a two-wheel trailer; four-wheel industrial truck, and skid mounting, for factory use are also available.

Gasoline engine and direct current motor driven models of its Flex-Arc cross field generator have been made available by the Westinghouse Electric & Mfg. Co. As stated in last year's review, this is a two-pole machine with only series excitations and features a practically constant welding current not only on the volt-ampere curve but also during transient

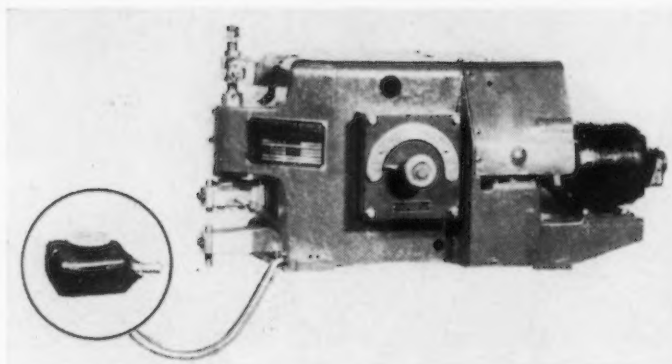
changes. Unusual arc stability and ease of control are claimed for these machines. A simple motor and starter voltage change-over switch of plug type has been provided to permit complete reconnection of motor and starter from 220 to 440 volts and vice versa in one operation.

#### New Automatic Arc Welders

Two or more new automatic arc welders designed to use heavily coated electrodes were brought out during the year. They feature increased speed together with more uniform density of weld as compared with manual welding.

Automatic shielded arc welding by what is designated as the Unamatic process was introduced by Una Welding, Inc., Cleveland. The automatic welding head employed is equipped with a mechanism by means of which tape coating is wrapped around the rod at a point between the welding head and the arc. The tape is impregnated with a slag and gas forming coating. The welding head, which with the new coated rod will weld steels ranging in thickness from No. 10 gage to 3 in., features control of arc length by two independent motors operating against each other through differential gears, which permits instant reversal of the welding wire without reversal of the motors. Either a.c. or d.c. may be used for welding. Full size 150 lb. coils may be used and long lengths may be welded without interruption.

Another automatic welding head, the Smootharc, brought out by



**B**ENCH-TYPE spot welder, the Thomson-Gibb model A, for mass production welding of small parts. Features include compactness, accuracy of timing and precise application of pressure.

the Harnischfeger Corp., Milwaukee, operates with any type of commercial electrodes—bare, lightly coated or heavily coated. Feeding of electrodes is continuous and is automatically regulated as required to maintain proper length of arc. It is accomplished by a feed screw control driven by a separate motor, which in turn is automatically controlled by the voltage across the arc. The electrode hopper is adapted to light or heavily coated electrodes from  $\frac{1}{8}$  to  $\frac{3}{8}$  in. Wearing parts of the machine are hardened and rotating shafts are mounted in anti-friction bearings. Shock absorp-

tion and overload protection are incorporated in the design. Simple adjustments adapt the machine to metals of varying specifications, mild steel to alloys. The simplicity of setting and operating the head is said to permit one attendant to supervise three or more set-ups simultaneously. The head can be fitted with special attachments.

Improved designs previously an-

late his voltage and current independent of the others and can compensate for line drop, has been developed. This regulation is accomplished through separate transformer reactor control."

Application of high frequency to the a.c. arc has increased, and this, according to Mr. Holslag, opens up a field for thin work in aluminum, nickel, monel and other

non-ferrous metals. The most recent development in the application of a.c. is the submerged arc, he states. In this a large bare wire electrode and very heavy a.c. are used to make a weld deposit in one piece under a covering of dry flux placed in the groove and heaped above it. Due to the heat released, this system is said to give very good results; it also lends itself well to automatic welding. As in other a.c. welding, absence of slag and gas inclusions is a feature, and improved grain structure of the welded joint is due to the reversal action of 50 or 60 cycle current, which keeps the puddle molten and allows more time for the formation of the desired grain structure.

### Induction Heating Applicable To Welding

A method of induction heating that has interesting possibilities in the welding field was brought to the attention of engineers by Prof. Edward Bennett, department of electrical engineering, University of Wisconsin, in a paper on "Electric Heating by Proximity Effect," at the recent annual meeting of the American Welding Society. At present the process is applicable to plates, tubes or other shapes, which may be heated for brazing, annealing, hardening, enameling and alloying, as well as for welding. It has been worked out in preliminary practice; the patents have been assigned to the Wisconsin Alumni Research Foun-



#### AT LEFT

**T**HIS welded steel frame, fabricated by Lukenweld, Inc., for a 2000-ton hydraulic press, consists of two 156 x 32 x 3-in. steel plates weighing 4352 lb. each, formed U-shaped and joined to make a band by butt welding the two ends of the U together. This reinforced weld takes the full tension load. The completed frame is 10 ft. 10 in. high and weighs 10,850 lb.

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#### BELOW

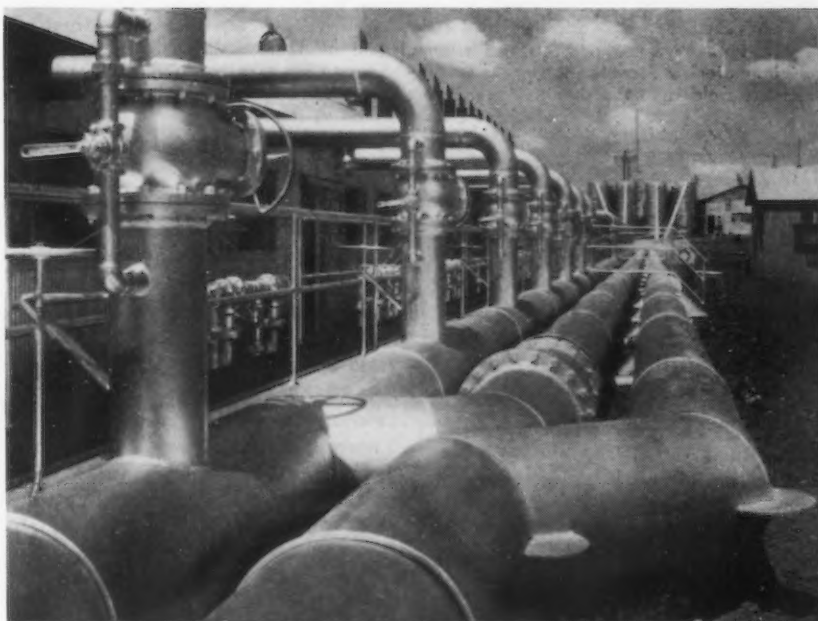
**W**ELDED manifold in refinery. (Photo by courtesy Lincoln Electric Co.)

nounced include the Electronic Tornado automatic welder made by the Lincoln Electric Co. In its present form this automatic welder is a self-contained unit designed for high-speed production of quality welds.

### Demand for A.C. Arc Welders Also Increases

Demand for a.c. welders, both for heavy fabrication and for light work, has increased, the latter involving small capacity, low-cost units for repair shops, garages and the like.

In new equipment, "C. J. Holslag chief engineer, Electric Arc Cutting & Welding Co., Newark, N. J., states that a ring system for multiple arc welding sets, whereby each operator can regu-



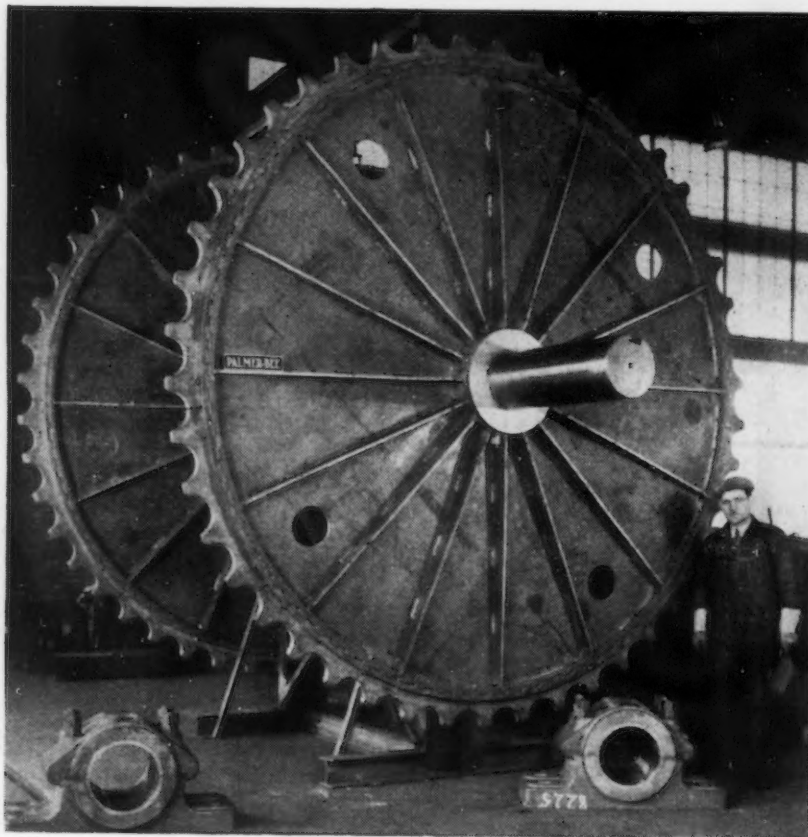
dition, but the process has not yet been applied commercially.

The method of causing the heating current to concentrate in selected narrow and shallow strips on the surface or the edges of large metallic bodies is to place the selected edges or strips in close proximity to each other, or in certain cases in close proximity to an auxiliary water-cooled conductor, and to so connect the

obtained with large sources of power at the higher frequencies.

## Electrodes and Welding Rods

PROGRESS in the application of welding has been aided considerably by the development of new electrodes and welding rods.



**A**LL-WELDED sprocket, for a vertical core oven drive, believed to be the largest of its type ever made. Web and stiffeners are of  $\frac{3}{4}$ -in. material and the rim of  $5 \times 2$  in. material. From rim to rim the wheel measures 12 ft. The teeth are steel castings which are welded to the rim, giving an overall diameter of about 13 ft. Specifications called for a finish within  $\frac{1}{8}$  in.

shapes (and the auxiliary conductor) to the source of a.c. that the current flows in opposite directions in the two edges. Under these conditions, the heating current, if the frequency is in the audio range of 500 to 20,000 cycles per sec., concentrates largely in the closely adjacent strips and does not disperse all through the bodies. For heating narrow strips on the edges of steel plates to welding temperatures, frequencies of the order of 2000 cycles per sec. and higher are essential. Actual experience is yet to be

A new electrode for bridging gaps where the fit-up between plates is poor and, in the smaller sizes, for use on vertical and overhead work or to make rapid single pass welds on light gage materials has been added to the Murex line of heavy mineral coated electrodes offered by the Metal & Thermit Corp., New York. This electrode, the type N, will also produce sound single or multiple pass fillets. It is said to work equally well with a.c. or d.c.

For welding the various new low alloy high tensile steels the

Champion Rivet Co., Cleveland, is offering a new series of electrodes with tensile strength ranging from 65,000 to 100,000 lb. per sq. in. High physical properties are attributed to the introduction of various ferro-alloys, including a small percentage of molybdenum, which tends to add creep strength to the deposited metal.

The Linde Air Products Co., New York, introduced a new heavy mineral coated electrode for shielded arc welding, the Purox type EHT, designed for downward position welding. Features include freedom from excessive smoke and fumes; protection of metal from oxides and nitrides; production of a heavy slag which not only protects the metal from oxidation but also slows down the rate of cooling; and prevention of excessive spatter loss, which enables use of higher current values. This electrode may also be used with either a.c. or d.c.

For welding 5 per cent chrome steel, used extensively in applications requiring high creep strength and resistance to oxidation, particularly crude-oil corrosion, the Lincoln Electric Co. has developed a "Chromeweld 4-6" electrode. For high tensile steels, the company is offering a "Shield-Arc 100" electrode, that produces welds having ultimate strengths of 100,000 to 105,000 lb. per sq. in.

A new electrode, the "Fleetweld 8," designed specifically for making fillet welds in mild steel was also announced by the Lincoln company. Fillets (one plate vertical) up to  $\frac{3}{8}$  in. can be produced in one pass, and these welds are said to be dense, smooth, have good physical properties and to show no undercutting at the vertical plate or overlap at the horizontal plate.

Still another Lincoln development during 1936 was the "Aerisweld" electrode designed to provide weld deposits having characteristics of true phosphor bronze with notably high tensile strength in welding bronze, brass and copper. The electrode is said also to weld many types of bronzes which are difficult to braze and to be particularly effective on galvanized sheets, where minimum disturbance of the arc is essential. Except on heavy bronze or copper, preheating is not necessary.

A welding rod claimed to enable the making of homogeneous



## Whitey Sez:

*"Inventories in the MAURATH stockroom are a big pain in the 'neck'. Constant turn-over amid the many sizes and analyses keep the shelves in a perpetual state of upheaval."*

MAURATH, INC., CLEVELAND  
BUILDER OF BETTER WELDING ELECTRODES IN ALL ANALYSES

THE IRON AGE, January 7, 1937—575

welds in any zinc or aluminum base metal is being marketed by the Aladdin Rod & Flux Mfg. Co., Grand Rapids, Mich. The same rod may be used also for rebuilding of worn parts.

## Hard Facing Applied to Wide Variety of Parts

INCREASE in the use of hard facing of steel parts in both single application and repetitive production fields is reported. In many applications the material is applied to resist abrasion or wear resulting from the friction of sliding surfaces; in others, to retain a keen cutting edge on blades for shearing, cutting or scraping. A number of hard facing materials including tungsten carbide is available to meet a wide variety of requirements, and application procedures and comprehensive cost calculation data have been worked out by various materials suppliers. Applications range from small valve facing to surfacing of large machinery parts. Steel mill uses featured during the year include the hard surfacing of rail mill guides, of furnace drums, and of the points of soaking pit ingot grappling tongs. The larger rail mill guides of one mill require as much as 4 to 5 lb. of the wear resisting material, but a definite lengthening of guide life, with freedom from shutdowns for guide changes, has been experienced. In the case of steel drums used for drawing long steel bars from heating furnaces, the hard surfacing is credited with increasing the life of the drums by five times.

## Resistance Welding Celebrates 50th Anniversary

FROM little more than a simple transformer with a clamp and a pair of electrodes, the resistance welder invented by Prof. Elihu Thomson in 1886 has become a very highly developed and widely used tool of modern high production industries. Although fundamentally very much the same, the

modern resistance welder is the result of a long series of important improvements in respect to methods of controlling the amount and duration of current and heat, method of applying pressure, cooling, and holding of the work. Speeds have been gradually in-

the extensive use of special fixtures and other devices at first associated solely with high production machine shop operations.

Although applied in some degree in almost every industry, resistance welding still finds its most extensive use in automotive



**F**ABRICATING the platens for an all-welded blooming mill manipulator at the Morgan Engineering Co. plant. The complete manipulator, weighing 1,575,000 lb., was made up of some 1975 pieces of steel ranging in thickness from 2½ to 20 in. More than 42,000 lb. of Murex coated welding rods were consumed in the 16,000 linear ft. of welding. (Photo by courtesy Metal & Thermit Corp.)

creased; from the maximum of 150 to 200 spots per min. 10 years ago, one hears today of machines making 200 and more spot welds in 5 sec. by hydraulic means. As in other branches of welding, modern machines are built to high standards approaching those of the machine tool industry. Another trend reflecting the meeting of mass production requirements is

plants. Applications by refrigerator manufacturers in the past year have been noteworthy, and greater use has been made in the aircraft industry. The trend has been toward semi and full-automatic machines, and welders with a multiplicity of transformers and electrodes have perhaps increasingly replaced standard single electrode units. As to range, the



**W**ELED locomotive trucks, end-frames and miscellaneous parts is greatly facilitated at the Erie works of the General Electric Co. by this rotary and tilting welding table.

process is being applied successfully even in the joining of a wide variety of dissimilar metals.

The following outline of new equipment and interesting adaptations in most cases represents only a few of the machines developed during 1936 by the companies mentioned.

#### Welders for Continuous Strip Mills

Several resistance welders for continuous strip mill use have been developed. For very wide strip, two machines are offered by the Taylor-Winfield Corp., Warren, Ohio. One is an adaptation of a spot welder where the head travels across the strip by manual drive and the weld may be made at any desired point in the travel. The other machine is a seam welder which is fully automatic and will make a continuous seam weld the entire length of the joint. This unit operates at a speed of 40 ft. per min. on 24 gage stock down to about 8 ft. per min. on 16 gage stock. In case a continuous seam is not desirable, the same machine can be equipped with electronic control to make a series of spots at predetermined intervals across the strip. This weld serves to maintain a continuity of flow in processes where overlap can be tolerated.

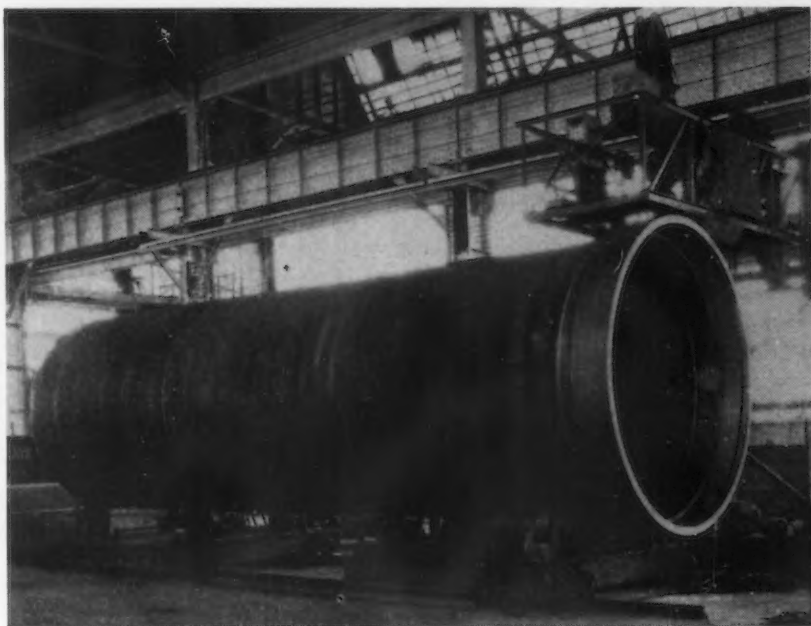
For use in connection with cold strip mill operation, the same company has developed a hydraulically-operated butt flash welder, a flash trimmer, and a hydraulic transfer for installation ahead of the pickling process. Coils from the hot mill are threaded through suitable rolls to feed them to the welder. Beyond the welder a loop-

ing pit is provided to take up the slack which must be drawn from by the pickling process while the weld is being made. One operator controls the threading rolls, the hydraulic transfer and the flash trimmer. The weld is said to be of such quality that it need not be cut out, and gives coils of any size the manufacturer cares to handle at the output of the pickling process. In one installation, five 4000 lb. coils are joined to make a 20,000 lb. coil, which is threaded into the cold strip mill.

A resistance flash welder of giant proportions was supplied by the Thomson-Gibb Electric Welding Co., Lynn, Mass., for joining wide material for continuous processing in a large steel mill. The layout includes a flash trimmer for removing the burr from the top and under side of the welded joint.

#### High Production Machines for Refrigerator Work

Special machines for refrigerator work include a fully automatic dual transformer four-roll series line welder with hydraulically driven traveling work-holder carriage, for the seam welding of flat condenser plates, a development of the National Electric Welding Machines Co., Bay City, Mich. After the two flat stamped corrugated condenser sections are clamped in place on the work-



**W**ELD fabricating a 40-ft. long, 10-ft. diameter evaporator shell at the plant of the Foster Wheeler Corp. G. E. automatic a. c. equipment is employed for the welding.

holder carriage and the operator starts the machine, all four heads move to the work, and the carriage travels automatically at a predetermined welding speed, making four seam welds at one time. At the end of its travel in one direction, the carriage stops, and the heads rise, and index to the next welding position and then move to the work. The table then automatically reverses at a predetermined welding speed, completing the next line of four welds. The 20 line welds between corrugations in the condenser plates are made in five table strokes, at the end of which the heads and the table automatically return to the starting position at fast speed. The machine welds at a speed of about 100 in. per min.

Another dual-roll series line welder was developed by the same company for simultaneous welding of tops and bottoms to refrigerator cabinets. It is equipped with a hydraulically-operated and automatically indexed traveling workholding fixture. When the parts

to be welded are air-clamped in the fixture and the machine is started, both welding rolls move into position and the fixture travels, making the top and bottom weld along the right-hand side in one stroke. The heads then rise automatically, the fixture returns to the starting position, at the same time indexing for welding the top and bottom seams at the left-hand side, after which the fixture returns to the unloading position. Production is at the rate of 40 to 50 of the cabinets an hour.

For welding of tops and bottoms to the sides and back section of refrigerator liners the same company has furnished a flash welder powered with two large transformers and equipped with special hinged air-operated clamps. This machine weighs about 7 tons.

#### Cabinet Liner Joints Welded Simultaneously

For simultaneous welding of two joints in refrigerator cabinet lin-

ers, ovens and other box-shaped sheet metal units, the Federal Machine & Welder Co., Warren, Ohio, has developed a 225-kva. traveling head roller seam welder. One model has two fixtures mounted on a track at the base of the machine, each with individual drive, so that while one unit is being welded the other may be loaded. The traveling head operates automatically after the cycle is started and the head returns to the starting position on completion of the weld. While the head is returning, one work holding fixture moves backward and the other moves into position for welding. Capacity is for welding 20 x 20 in. ends in 45 rectangular boxes an hour, totaling 5400 in. of welding.

The same company brought out a small flash welder featuring accuracy of alinement in the welding of light gage stampings. It is designed for refrigerator cabinets, automobile fenders and other sheet metal parts that require accuracy of clamping, doing the same class of work as large automobile body welders. This is a 200 kva. machine of unusually rigid construction, and will handle sheets up to 30 in. wide.

#### Double-Head Projection Welder

Developments by the Swift Electric Welder Co., Detroit, included a double head projection unit for welding base hangers for refrigerator boxes. This machine is designed to permit assembly of large parts under the machine and welding at different points, and is equipped with a suitable holding and alining fixture. One head welds at a time, each going through its cycle independently of the other.

In another Swift machine the spot welding electrodes may be removed and projection welding dies fitted to the T-slotted tables. Welding pressure, obtained from a direct single-acting air cylinder, is adjustable. For welding 0.010 in. stainless steel, the machine was equipped with Ignitron control. A projection welder for automobile brake parts features a double pressure arrangement—low pressure for heating the work and high pressure for upsetting, a set-up emphasized as materially lowering peak current demands and producing a better product than is possible when only one pressure

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is used for both heating and up-setting.

For welding corrosion-resistant steel in shipbuilding work, the Thomson-Gibb Electric Welding Co. recently supplied a special 150-kva. press welder with capacity for making 30 to 40 spots per min. in 3/16 in. material. A special split-type head is equipped with a hand lever for accurately locating the upper electrode on the work before the power driven mechanically operated pressure device goes into action. This feature permits making spot welds on somewhat lighter material through manual operation of the upper head.

#### Mash Welder for Heavy Steel Gratings

A multiple projection welding press designed for mash welding of heavy steel gratings was another interesting machine furnished by the same company. It is built along the lines of a four-

post hydraulic press, with the bearings of the upper or movable platen sliding on the posts. Pressure is supplied by a double-end cylinder with large area on one side and a small area on the opposite side for returning the ram to the open position. The ram, with a stroke of about 6 in., can be operated by an accumulator or an Oilgear pump at 1000 lb. pressure. The transformer, rated at 700 kva., is made up of four water-cooled units of 175 kva. each. The machine weighs 25,000 lb. and will handle work up to 23 in. wide.

Two thicknesses of 1/2 in. flat bar stock or of 3/4 in. round stock can be welded on a recently built Thomson-Gibb duplex motor-driven press welder. This machine which weighs nearly 8 tons, is powered by two water-cooled, 400-kva. transformers and delivers pressures up to 4000 lb. Two pressure heads operating through a common camshaft are driven by a

3-hp. motor through a speed reduction unit. Strokes range from 10 to 30 per min. Welds can be made at any point from 4 to 40 in. apart on a circle by swiveling the electrode holders and moving the arms in or out.

A simplified Hydromatic welder for welding hood panels was among several units supplied by the Roth Welding Engineering Co., Detroit. This new machine incorporates a controlling device which automatically adjusts the welding time as well as the successive speed of the welds according to metal thickness. As there are few moving parts, service and maintenance charges are low.

#### Dissimilar Metals Joined

An unusually interesting dissimilar metal welding job is in connection with the coils of large revolving electrical equipment. These are wound of aluminum in order to reduce weight, but have a



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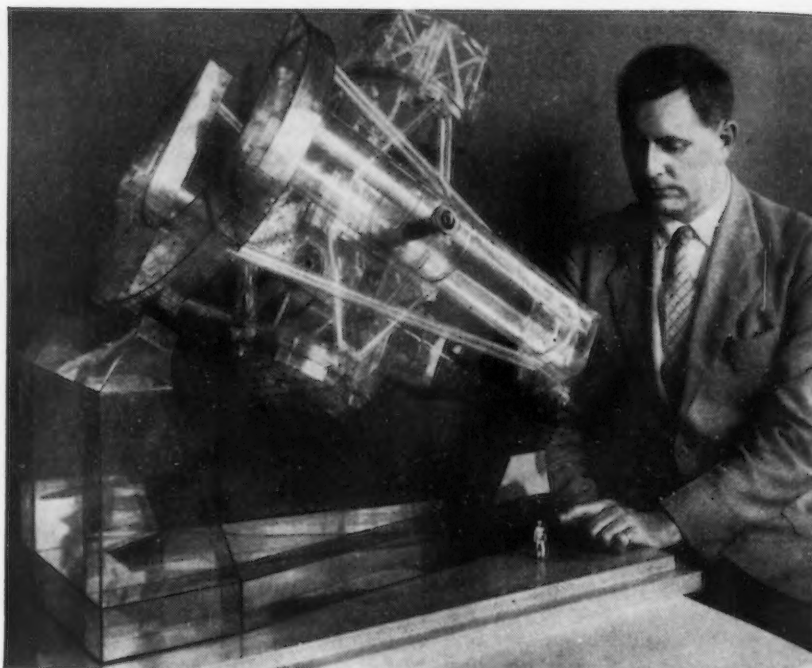
copper end, which is butt welded to the aluminum.

The application of resistance-welding machines to the fabrication of high-strength aluminum alloys requires the close accuracy of control. This metal is being broadly applied in the manufacture of airplanes, and the use of resistance welding is reported to save approximately 3c. for each weld as compared with riveting.

#### Improved Control Units

A combination spot and seam-welder control unit utilizing power tubes has been designed by the General Electric Co. for use in the fabrication of aluminum alloys. For spot welding, it is adjustable in half-cycle steps, while for seam welding, both the "on" and "off" timing is adjustable in half-cycle steps. It is equipped with water-cooled sealed-off ignitron power tubes and is located in the primary circuit of the welding transformer. Another feature is the dead-front time-adjusting panel.

A switch is provided to permit selection of the mode of starting the antipole or unipolar current flow for both spot and seam welding. Heat control is effected by the phase-shifting method which



AN outstanding arc welded structure—the mounting for the optical system of the 200-in. telescope to be erected on Mt. Palomar, and being fabricated at the South Philadelphia works of the Westinghouse Electric & Mfg. Co. It is remarkable both for size and for the accuracy with which it must be fabricated and machined. Permissible error in sighting must not be greater than the angle formed by two lines 3-in. long subtending an arc equivalent to the thickness of a 25-cent piece. The tube member is 60 ft. long and 22 ft. in diameter, and the complete telescope mounting will weigh more than 1,000,000 lb. The celluloid scale model (pictured above) was built to study the design and rigidity of the structure. J. Ormondroyd, Westinghouse experimental engineer, is pointing to a mannikin which shows the relative size of the telescope as compared with an average size man.

eliminates the need for the usual taps on the welding machine.

This equipment is extremely flexible and it is easy to change it from one control setting to any other for different classes of work by use of calibration charts; settings can be checked by means of the inkless oscillographic type of recorder mounted on the panel. An auto transformer with taps is provided to permit operation of the control on any line voltage between 200 and 600 volts.

The company's reversing-type Telechron-motor-operated timer has been superseded by a design which utilizes a fractional horsepower gear-motor which operates in conjunction with a magnetic clutch to determine the timing. A single dial permits accurate adjustment. The timing range is from 3 to 40 cycles of the 60-cycle power supply. Advantages include long-life gears, more accurate timing, and shorter minimum time setting. The new unit resets, making ready for the next weld in less time than is required to make the weld. There are large silver-faced tips on the timer to give greater current capacity.

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# SUPPLIERS OF PARTS AND PRODUCTS

*Now that demands are increasing along all lines, the man with a better method or product has plenty of opportunity to reap a harvest.*

By FRANK J. OLIVER

*Detroit Editor, The Iron Age*

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THIS article is an attempt, by no means complete, to analyze some of the problems

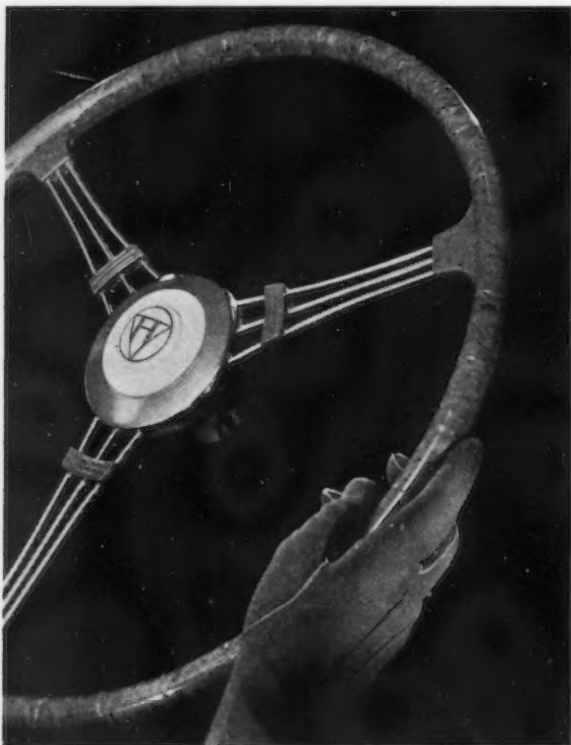
confronting those fundamental industries that furnish parts on contract to fabricators of completed products, and to point out what means are being taken by them to meet competition within their own specific industries as well as competition from materials and parts outside their respective industries.

In the past year, the race has become keener than ever between competing materials and processes. Most of the brunt of the battle is being taken and its major strategy directed by the contract parts shops whose very existence depends upon the stimulation of new ideas. The

work of conversion goes on apace. Plastics do the work of die castings and stampings, and the latter two battle for markets between themselves. Forgings fight for position against stampings and malleable iron. The latter loses ground to stampings here but gains a new application elsewhere. And all these companies are confronted by the competition of the manufacturer who wants to supply his own semi-finished parts. Many of the ideas presented here are not new to the specific industries, but a review of the practices of one may

be revealing to operating executives of another field, and the parts buyer may learn something too.

The question often arises as to whether it is cheaper for a manufacturer of a completed product to make his own parts or not. Every parts maker has been faced with that threat one time or another. The answer up until now seems to be to leave the specialties up to the specialists. There are over 75 custom die casting shops in the country, and the custom molders are becoming legion. Stampings plants are found in every city, and the



o o o

**I**N the compass of this small photo is a battleground of competing materials. Wheel rim is Tenite molded over a steel core, but the hub is a die casting. The Electric Hand (also a contract part) has been made both with a die cast and a plastic arm.

o o o

drastic swings, while they seriously inconvenience the big corporation shops, have minor effects upon their financial position, usually secured with huge cash reserves. In fact, such reserves make for flexibility in manufacturing policy, cost being no immediate objective. To the independent parts plant, however, such switches often mean life or death.

### Between Frying Pan and Fire

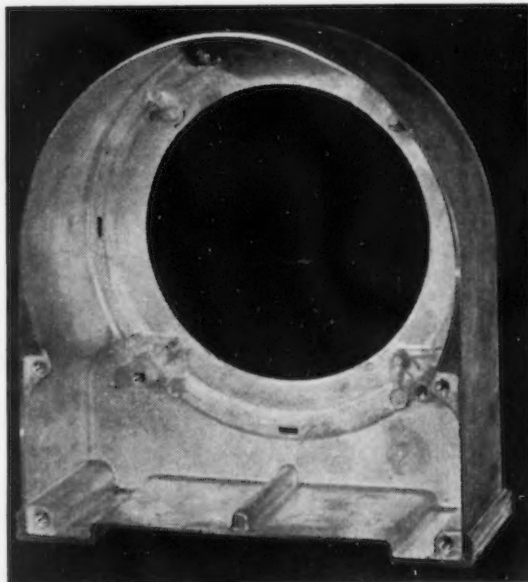
They are placed in double jeopardy in labor warfare. If they are closed down, loss of business is incurred. If they accede to labor's demands, which generally call for wage increases, they are caught in the squeeze of the big buyers who are fighting for price advantage, and who usually contract for their requirements on a 6-month basis. In fact, with equal wage rates, the product manufacturer can generally convince himself of lower costs

jobbing foundry is just around the corner. The chief advantage to the buyer is the pooling of experience on a dozen different jobs that the contract shop is able to bring to his particular problem. This experience is only obtained at the expense of trial and error, as many a manufacturer has discovered after pulling in a job from the outside.

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### BELOW

**F**ISHING reels with end housings and knobs of molded Tenite. Metal inserts and other screw machine products, plus stampings, make up the remainder.



o o o

**I**MPROVEMENTS in die casting techniques have enabled thin-walled castings to be made, such as this clock case, formerly drawn from sheet brass. Bosses are already in place, with cored holes ready for tapping. Plastics can also do the same job.

o o o

During the past month a new factor has come to the front, threatening the very existence of the contract shop. That factor, as it relates to automotive parts suppliers, is the struggle of organized labor to unionize the industry through tie-ups of parts plants. As a result, the large manufacturers have done one of two things or both: They have switched parts contracts from the affected plant to another source, or they have applied every facility to tool up and get into production themselves on the particular component. Such

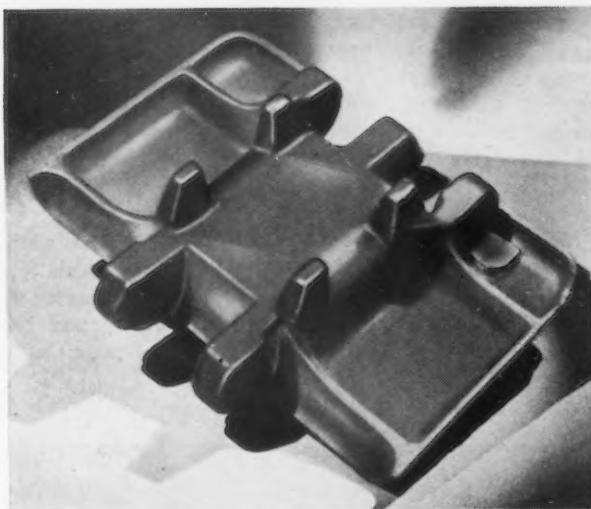
in his own plants since selling expense is absent. Perhaps the most important factors halting the drift in this direction are the inability to apply complete technical supervision over the intricate maze of manufacturing techniques involved; the operation of the law of diminishing returns as the size of the project increases (although the success of the largest operator in the business belies this theory); or the location of parts plants in the smaller cities where wage differentials naturally exist under those in large urban centers—a strategy

open to the manufacturers themselves where a decentralization policy is operative.

Specialization is the most practical answer to this general problem. It does seem apparent in the last year and certainly during the depression that the most successful contract parts firms were those who specialized. It is the most practical way of getting out of the purely price competition class. That and a reputation for extremely careful work. An electric steel foundry, for example, saw its heavy-duty truck market falling away (it has yet to come back), and several years ago began to specialize

FORGE shops in turn go after conversion business. This track shoe for a steam shovel, formerly a casting, is now a steel forging as a result of the development work of the contract parts supplier.

Photo by courtesy of Atlas Drop Forge Co.



IF the stamping plant can do some initial assembly operations on the piece so much the better. Pipe nipples and the bracket have been electrically brazed.

in corrosion and heat-resistant alloys. Now over half its output goes into high alloy steel.

It specialized not only in its product, but also in its markets. During the depths of the depression it picked companies that had reserves and could afford to spend money on new developments when others were holding back. By this approach it pioneered stainless steel castings, for example, to replace bronze and brass fittings in the sulphite paper industry. It went after replacement business first, and after it had developed acceptance by the leading companies, it went after the original equipment makers. This steel foundry, incidentally, "develops" over three-quarters of its alloy casting business. It maintains a small staff of designing engineers who spend

their time on customer problems, mostly on conversion work. The company has obtained many patents on such developments which their customers use. Naturally,

such patents give this company a proprietary lien on any subsequent business. Another foundry in the same field has also recently taken an aggressive policy in this direction and has reestablished its position in the market.

#### Keen Competition in Steel Castings

Steel foundries that do not adopt such policies must face competition of the keenest sort from within and without. They usually contract for a manufacturer's requirements on a price-per-pound basis and trust to luck that they will get the breaks on the type of castings that are sent their way. A biased purchasing agent can ruin such a foundry by giving it all the difficult jobs, because obviously true costs vary widely from the overall figure. Often the company that makes part of its requirements and jobs out the rest gives out only the fussy and difficult jobs. Yet it expects the contract shop to be in line with its own costs—costs that

THE installation of a controlled-atmosphere, electric brazing furnace enables a contract stamping shop to extend its stamping applications by this method of assembly.

Photo by courtesy of Acklin Stamping Co.



are not always arrived at fairly because they do not take all the factors of overhead into account. Castings that run oversize and thereby increase machining time and costs, for instance, are accepted from the corporation's own foundry, whereas they are rejected if they come from the contract shop. All of which adds to the costs.

Buying of steel castings for the railroad field is generally by the

is most scientific but sometimes does not mean an awful lot in the long run where competitive conditions establish the price per pound in the market.

### Estimating on Gray Iron Castings

Yet the author is acquainted with a specialty gray iron foundry that estimates every single job on a per pound basis. There is no such thing as contracting for a

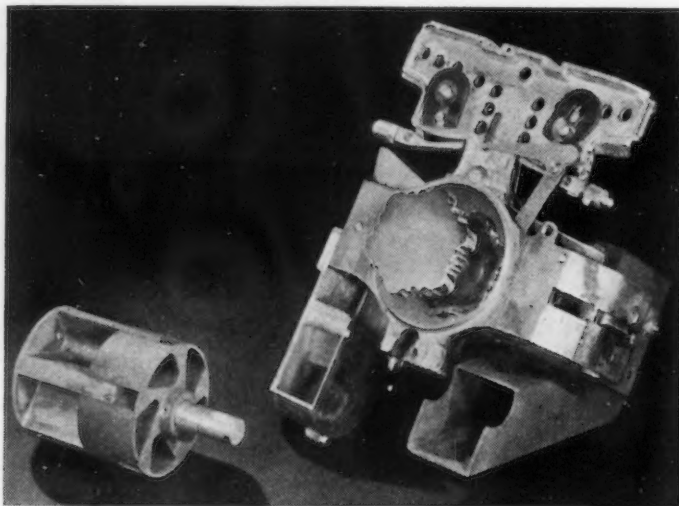
is built up, it will command a price in the face of any competition. Such a foundry has got work at 100 per cent higher price over the lowest bidder who had yet to establish confidence as to his reputation and integrity.

### Precision Parts

Certainly in the manufacture of precision parts, the quality standards and reputation of the contract shop count more than the price per piece. You can count on the fingers of one hand the parts makers that are eligible to supply the leading aircraft engine manufacturers, particularly on government work. The average fabricator of hardened and ground parts will have a hard time to break into this field by bidding for work on a price basis. The mere fact that his price is low lays him open to suspicion, for the engine companies know by experience in their own shops what the percentage of rejected pieces means in terms of costs of those parts that pass extremely rigid inspection. Specifications are being drawn tighter every year and on some engine details the tolerances approach those of gages.

Companies in this line find that precision must be carried right back into the screw machines that rough out the blank from the bar; that single-point diamond or carbide tools must be used on secondary operations in the soft and that the fixtures and tooling must be elaborate to give tools and work proper support. Heat treatment must be controlled precisely and grinding must be carried on at a slower pace with finer grit wheels. There is more honing, lapping and polishing being done. Inspection departments have been trebled and quadrupled in size in recent years. Then there is the follow-up man who coordinates the manufacturing program so as to reduce buck passing on errors. All this costs money, but the quality customer expected this because his product may often mean a matter of life and death.

Among the top notch contract shops that supply this field there is naturally some rivalry on a price basis and there is some opportunity for ingenuity in production methods, since although the end point is rigidly drawn by specifications which are seldom altered, the method of arriving at this result is a matter of individual choice.



**T**HIS intricate die casting of a coin device on a nut vending machine was worked out by a custom shop to substitute for a group of stampings and gray iron castings. Time of assembly is said to be greatly reduced and accuracy improved.

*Photo by courtesy of Doehler Die Casting Co.*

lot. This method is not always satisfactory in the long run to either party. Usually the foundry does not build up enough experience on any one part to get the cost down to a reasonable figure; the work is generally placed on a price basis and there is no incentive for a supplier to build up prestige for quality work. Standards of acceptance are often low, and in the examples of car castings the car company feels that it is up to the railroad to pass on the quality of castings. Yet the railroad's contact with the foundry is indirect.

There are so many variables in jobbing foundry costs that accurate cost methods seem more trouble than they are worth. Some contract shops keep none at all and trust to the general bidding trends. Some keep costs on the basis of monthly tonnage (and find the figures vary with the per cent of loading), while others attempt to keep costs per piece. This method

manufacturer's requirements for six months at a flat rate per pound. And these are not production runs either. They are tool and fixture work, experimental machinery and parts-work, incidentally, where being right counts much more than first cost. Often the work is done on a cost-plus basis. Intricate castings requiring accurate core work have been sold for as much as 80c. a lb. Another example of specialization.

How does such a foundry get that way? By establishing a reputation for painstaking work, by taking time to see that the work is done right, by setting its own quality standards higher than its fussiest customer, and by using modern equipment and modern foundry techniques. It has both a cupola and an electric furnace, besides modern sand preparation equipment and the latest in heat-treating furnaces. All this costs money, but once such a reputation

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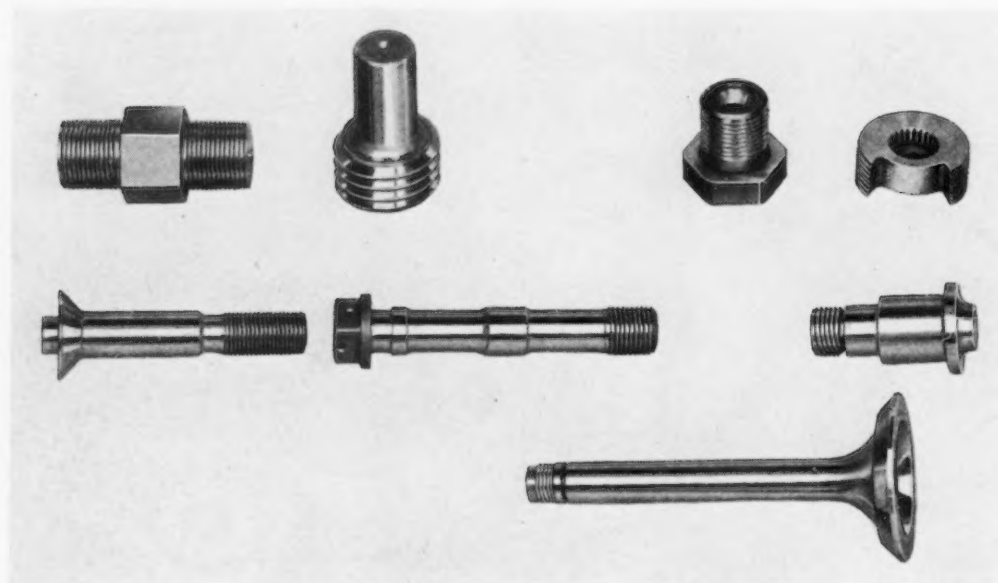
Whether one should grind airplane engine stud threads or mill them is right now a disputed subject, one school taking the attitude that grinding corrects any errors following heat treatment and eliminates tool marks that may initiate fatigue cracks; the other insisting that a 2-hr. job of carefully grinding the thread milling hob inherently builds accuracy into that hob which excels that of an 8-min. grinding job on each individual stud. Both studs and thread mill-

should be made of a successful stamping plant that employs carefully worked out machine-hour burden, and has managed to stay in the black throughout the depression. Like the steel foundry mentioned, it selects its customers and refuses to accept business at what it knows to be less than cost. It watches machine load rates and spots the chronic non-producers or the low-profit jobs. If it can't keep a certain class of machinery busy, it throws it out and puts in ma-

adjusted monthly, if necessary, to relate activity of each department to true costs. Most variations in estimates are due to lack of scientific cost keeping. Some parts buyers often run parts in their own plant for price control, and while such costs are not always comparable, they do tend to keep bids in line.

### Material and Labor Cost Changes

Much contract work is written on a six-month basis. This is



**TOLERANCES** on aircraft engine and component parts are rapidly approaching gage limits. Many pieces, such as the propeller bolt at the left, are ground all over, including the threads. Reputation counts more than price for this class of contract work.

*Photo by courtesy of Ez-Cell-O Aircraft & Tool Corp.*

ing cutters are ground on the same type of equipment, however, and accuracy is inherent in the machine. There is a definite swing toward rounded thread roots and crests to prevent fatigue failure under vibration.

### Close Inspection

Inspection methods in such shops are carried to the point where errors are exposed that the average shop overlooks. Magnaflux inspection is a requirement on all government aircraft work and is being extended into commercial work daily. By this method of magnetic inspection, hair line cracks, due to grinding, for example, are revealed even if below the surface. Work that appears perfect to the naked eye has to be rejected and this procedure adds to the cost of the perfect parts. Accurate estimating and accurate cost control are essential in work commanding such a high price.

Speaking of costs, mention

chinery that can be profitably employed.

Any production parts, such as die castings, are susceptible to this careful cost procedure, but in a jobbing steel foundry, it is well nigh impossible to figure on anything other than an average cost per pound over a month's run and trust to luck. Specialty steel foundries, however, find it expedient to estimate each job and to figure costs accordingly. Contract die shops have practically got down to a cost-plus basis, but this ideal arrangement is possible only when confidence of the customer has been fully established. This frees them from limitations on labor costs in competition with the corporation shops.

The consensus of experience seems to be that accurate cost methods pay and most group trade associations are working toward establishing standard cost methods for bidding purposes. Cost control is essential, and burden should be

particularly true in the buying of parts in the automotive industry, an example of which was recently brought to mind. A forging shop had contracted on such a basis without covering itself on raw material price changes. Price increases came through and the only recourse this shop had was to throw itself on the mercy of the purchaser and ask for a chance to revise the contract. A neighboring forge shop doing business with a similar class of customer never makes six-month contracts. If there is no other way of getting business, the only protection available is to schedule the unit price on the basis of a scale of raw material prices. Stamping plants usually do not contract for a period beyond the current quarter.

Discussing raw materials, one stamping executive recently made this remark: "We can pass along increased material costs to our customer, but we'll have to absorb any increased labor costs, which seem



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# STANDARD

inevitable." This brings up the point that it is easy to convince the P.A. of the justice of raising parts prices on the basis of tangible increases in raw materials, but he is adamant when faced with the increased labor cost factor since it is intangible to the extent that it is usually loaded with overhead. This being the case, the only recourse the supplier has is to use all the ingenuity at his disposal to cut corners on production costs. This means a careful study of each job, time study, motion study and study of handling methods, in which are many hidden costs. Shop service facilities should not be



**STOP!** But not the progress in materials. Once a stamping, this street marker is now a malleable iron casting as the result of an intensive engineering development program on the part of the contract foundry.

*Photo by courtesy Michigan Malleable Iron Co.*

overlooked in such a research, either.

Speaking of labor costs brings up the complaint that is sometimes heard of the competition by the corporation shop for men developed and trained by the contract shops. When a large manufacturer raises wages 5c. an hr., for example, it tends to draw in skilled labor from the jobbing contract shops. Men are often pulled away at a time when the very customer is clamoring hardest for delivery and when the purchasing department is refusing to recognize legitimate increases in labor costs. There is no way of meeting this sort of customer competition except by increasing wages, for there are usually other incentives in the product manufacturer's plant, such as steadier work, particularly in the case of seasonal industries. Variations in activity are much more severe in the parts plant, particularly where the customer is making part of his own requirements.

#### Migration of Designers

There is one place where the parts plant has the edge on the

labor market and that is in the design department. An exceptionally brilliant man may be making \$200 a month as a designer, for instance, in a large automotive drafting room. In the past few years many of the clever designers in this country have gravitated to the smaller parts, tool and die shops where they can earn \$400-\$500 a month as sales engineers, chief engineers or shop executives. That is why today it is not stretching the truth to say that 70 per cent of product design changes come from the contract shops.

Why shouldn't they? There is nothing like healthy competition to keep a shop on its mettle. These contract shops are fighting not only for their share of the business in their field, but are constantly encroaching on the field of others. In self-defense, the parts vendor must have a large development staff.

Recognizing this situation, the automotive industry in particular deliberately leaves the door open

either in the way of improving quality or cutting costs or both. This is one of the principal reasons why every year the public gets a better automobile for the same money or less. In one low-priced car, to cite a specific case, the number of parts has been increased by 40 per cent in the last decade, but the selling price has varied only a few dollars. There are hundreds, even thousands, of brains all working toward one end—and the limit will not be reached for many years to come. There is a principle involved here that many other industries, with closely guarded factories and secretive methods, could well follow.

#### Sales Value of Engineering Service

No matter what the article may be, all contract suppliers agree that engineering service counts more than price does in getting business and establishing confidence. There is only one possible



**SOME** of the possibilities of injection molding are the forming of a bezel frame around glass (8 x 3 3/4 in.), and the striking finish effects when the thermoplastic is molded around a die cast core.

*Photo by courtesy of Erie Resistor Co.*

for ideas to filter in through this source. The practice of issuing monthly passes to sales engineers of vendors is an open invitation for these men to come in at any time and hunt for conversion jobs. The stamping man is more stamping conscious than anyone in that plant. It will be he who will suggest ways of accomplishing with a stamping the same result obtained by a casting or a forging. The malleable man, in turn, will be equally alert in advancing his own art over steel castings, forgings and what not. The suggestion is

drawback to furnishing free development service to the customer. Some unscrupulous buyer may take a particular vendor's idea and peddle it around for a better price. This unfair advantage has been taken often enough to discourage some contract parts shops from doing more than just quoting on the blueprint or sample submitted. Most suppliers, however are willing to assume the good faith of the buyer and offer all the engineering assistance their facilities can provide, in the hope that their pains will be rewarded by at least the



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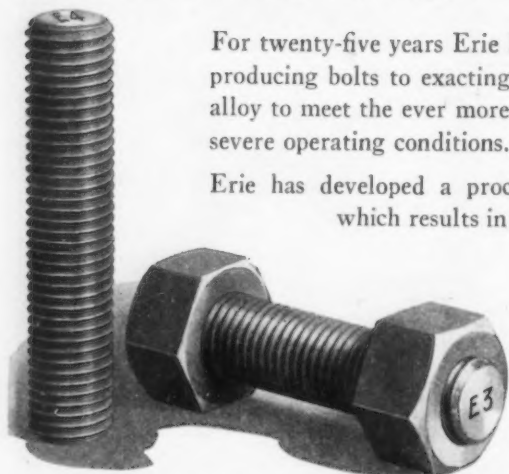
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majority of the business where more than one source of supply is the rule. And with the labor situ-

ation as it is today this is the rule. Many times a parts supplier must go to considerable expensive devel-

opment work to create new fields for its product. The advantages of aluminum cylinder heads, for example, had to be sold to automobile manufacturers. Elaborate dynamometer equipment had to be installed to test and prove that the added performance was worth the increase in price. Aluminum pistons had to be developed by the parts vendor and when light-weight alloy steel pistons cut in on their field, new pistons had to be invented to meet the objections of high expansivity and meet it at a cost equal to plain aluminum pistons. One result is the Nelson Bohnalite Autothermic piston in which the expansion is controlled by thermostatic elements of aluminum and steel in the form of strip inserts. By this device pistons can be made to shrink upon increasing temperature, if need be.

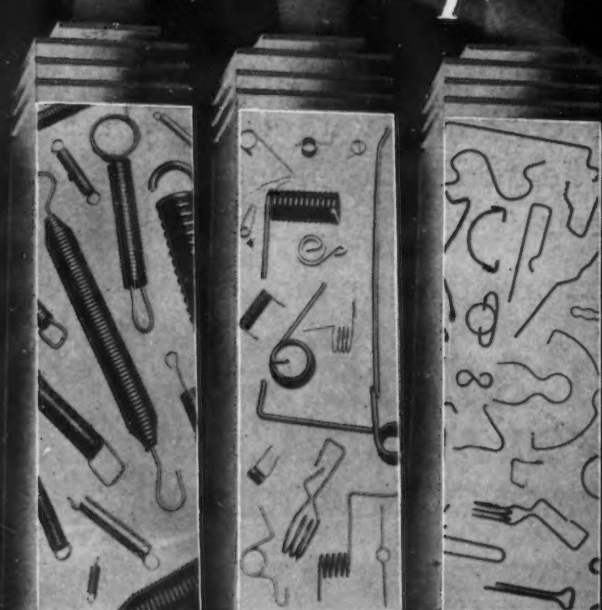
Often times a vendor is given only a detailed drawing of the piece he is expected to supply and only by consistent inquiry can he find out what it goes with. When he does, he can often make suggestions for modifying a part with a view to cutting costs. This is the way hollow-section extruded bronze and aluminum window frames were developed. The fabricator didn't think closed sections were possible and had detailed two right angle pieces which were dovetailed at the corners to form a square section when assembled. Once that idea became apparent, the extrusion plant engineers began to figure ways and means of getting rid of the dovetail joint and extruding the hollow section as a unit. The method is still a matter of trade secrecy, but it is being accomplished, indicating one more example of basic development by the contract shop. The same company has also pioneered the use of extruded aluminum shapes for belt molding on house trailers.

### Selling the Engineer

One of the problems common to all contract part shops is that of reaching the man who controls the initial design. Often this is some obscure draftsman who may never be allowed to interview the vendor's sales engineer. Yet he is the man who lays out the job as a casting, a stamping, a die casting. It would pay both parties if the vendor's engineer could place at the designer's disposal his own specialized knowledge, particularly of

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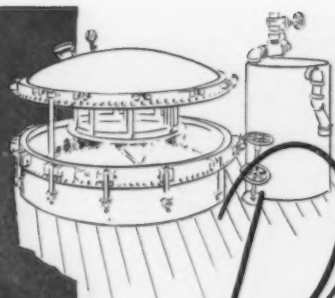
the technique of making the particular part.

In a general way, all kinds of devices have been taken to educate the designing engineer, starting right back in the engineering schools, where much of the ground-work could be laid, but where specific information on technics is often lacking. In a survey, for example, the Drop Forging Supply Association discovered only one engineering school in the country with an up-to-date forging hammer. The rest taught only hand blacksmith methods in their machine shop practice courses. The association is trying to correct that condition so that engineering graduates will be forging conscious. The American Foundrymen's Association is definitely aiming an educational program at the designer and has produced the "Cast Materials Handbook" for his aid as well as for the foundryman's. College boys are still told to stay away from press shops because they are too dangerous. As a result, too often stampings are designed by men who never had any experience with press work.

#### Automotive Industry a Factor

Fortunately for the custom stamping plants, however, the deck is loaded in their favor, particularly in the automotive industry. Several of the large corporations have production engineers whose sole purpose is to hunt up and study parts that might be converted from a casting or a forging into a stamping. These engineers are stamping conscious; they know stamping practice and stamping costs. They work with the contract parts shops. It was because of a set-up of this kind that a leading automobile concern dropped die cast radiator grilles and went back into stampings for 1937 cars as a means of cutting a few of the cost corners. Custom die casters did not worry, however, because in the meantime the banjo type steering wheel had been popularized. The poundage of die castings going into the hubs of these wheels offsets any losses from grille business.

Apropos of this it might be mentioned that one of the largest die casters takes great pains to educate its customers' engineers along die casting lines. Rather than keeping its methods secret, it welcomes plant visits from these men and takes pride in having some part in their education. These



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men, whom they help to train as die casting specialists, are in a position to extend some real co-operation. The friendly relations built up are helpful, but most important, the die-casting parts sent out for bid are correctly designed for most economical manufacture. This contract shop in turn uses as sales engineers only plant trained men thoroughly familiar with production problems, and college graduates wherever possible.

#### Changes Follow Trends

Occasionally, design trends force parts companies to add manufacturing facilities far from their original field. The swing to cast iron brake drums, to cite one example, forced wheel companies into foundry work. Two leading makers proceeded to put in their own foundry equipment to meet their customers' requirements. More recently a third company erected on its own property a foundry building which is to be equipped and operated on contract by the personnel of a jobbing foundry whose base is a hundred miles away. Thus the specialty foundry will assume full technical control, and incidentally a patented process of centrifugal casting will be employed. This case is unique in contract shop cooperation on a joint problem.

Sometimes tremendous savings can be made by substituting one

material for another, but it does not always pay to pass on all the gains to the customer in the first year. A good example is where a stamping plant converted a gray iron piece into a stamping. The cost of the casting was 62c. machined. The stamping price, although it had 32 operations, including seven draws, was set at 26c. It did just as satisfactory a job—in fact, a better one since it eliminated breakage, so there was no question as to the plant's decision. After this job had been run for some time, however, it was discovered that maintenance costs on the drawing tools was much higher than had been foreseen. So the custom shop went to the buyer and tried to raise his price 2c. a piece. This was an automotive part that ran into a hundred thousand units a month and 2c. meant not 2c. but \$2,000. What a cry was raised! It wasn't until shopping around proved that the nearest reliable competitor would not shoot lower than 32c., that the original vendor, who had developed the idea in the first place, got his price increase and retained the business. The moral of the story, of course, is to shoot high at first as long as the business is assured on the basis of engineering development. It is easy to lower the price when the competition begins to cut in on a price basis. The original supplier

always has the edge on the basis of experience with the job.

#### Getting Out of Competition

There are a number of ways of taking a parts company out of a strictly price competitive situation. One can always add equipment to increase quality or do the job differently or add a service the other fellow hasn't got. The Acklin Stamping Co., Toledo, for example, has just recently installed two electric brazing furnaces for carrying on assembly operations on stamped parts. One is a 20-kw. box type furnace; the other is a 45-kw. unit with mesh belt conveyor. As is well known, the brazing material, usually in the form of copper wire or strip, flows into all joints by the aid of capillary attraction and a reducing atmosphere in the furnace serves as a flux. At Acklin, this atmosphere is prepared by the partial burning or cracking of city gas. The parts come out of the furnace not only with a firm, strong bond, but with clean bright surfaces owing to the reducing atmosphere.

These furnaces, which are said to be among the first of their kind installed in a jobbing stamping plant, not only permit assemblies of stamping to be made, but also permit the company to make up composite pieces from stampings that might otherwise be considered only as screw machine products. The thimble illustrated is a case in point. It is a brake part and is made up of three simple stampings electrically brazed to form a single piece. Top and bottom washers are formed by punch press operations and the central tube is curled from flat stock. The washers have friction fits on the tube and the brazing material is copper wire wound around the piece.

Another example of gaining an edge on competition by the purchase of new equipment is found at the Melling Forge Co., Lansing, Mich. The recent installation of a Tumblast cleaning machine has reduced the cost of descaling and produced a finish on a drag link part needed to meet the rigid quality standard of the customer. Incidentally it eliminated a subsequent machining operation.

A few years ago, the Detroit Malleable Iron Co. put in the first Holcroft electric short-cycle annealing ovens to replace the old

pack-type furnaces formerly used. Using a controlled atmosphere, the furnace permits a short-cycle anneal of 10 to 24 hr. compared with 80 hr. in best pack-annealing processes and with as much as a three-week anneal in older types of furnaces. This particular installation has made possible the rapid shipment of castings, a vital factor with a contract firm servicing the automotive industry primarily, has increased the quality of surface appearance tremendously and has partially aided in increasing the physical properties through rigid control of furnace temperature and the cooling rate, particularly through the recalescence point. Other factors relating to physical properties were obtained by special analyses as a result of a metallurgical research program and improved melting practice. Castings with yield points of 45,000 lb. per sq. in. are now commonplace with ultimate strengths running around 65,000 lb. Size variations have been brought under control by improving pattern practice and by straightening the castings in forming presses. As a result, much less machining is required. Manufacturing costs have been reduced and quality raised.

This example is typical of what is going on in the malleable iron industry and accounts in part for the inroads made in the truck field where steel castings have heretofore predominated. Such accomplishments are also responsible for retaining what business might otherwise flow to stampings or forgings.

#### Cast Iron Dies for Stamping

Stampings are replacing castings to some extent, but then, too, most of the large stamping dies are made of high-test gray iron by contract shops. In fact, castings for body dies have become such a specialized business that some foundries concentrate in this field. One of them, the Detroit Gray Iron Co., installed an electrical vertical carbon-arc type furnace to super-refine its cupola iron for this class of work. The company also added molding pits capable of taking castings up to 50 and 60 tons. This is an example where a contract foundry not only anticipated the demands of its customer but even went a step further in furnishing special alloy irons for the trade.

Apropos of body dies, the trend

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has been definitely toward fewer and larger stampings, necessitating larger dies. This has meant that not only the few big body plants (which also are contract parts makers) but also the contract die shops, have had to purchase machinery of much larger capacity to finish the castings. This again brings up the point that new equipment is something that every contract shop, whether it be furnishing tools, dies or production parts, must buy in order to keep ahead of the crowd.

Forge shop equipment and hence practice is still pretty much behind the times, but the larger corporations are beginning to put in some of the newer forging machinery that is improving quality and cutting costs. Forgings are being made today on extra-heavy steam hammers faster and more nearly to finished size. Contract shops will have to install similar equipment not only to meet the competition of the corporation shops, but also to combat competition from other fields such as malleable iron, steel castings, stampings and welded fabrication. Already, foundries have begun to cast camshafts and crankshafts, heretofore considered solely in the field of the forge shop.

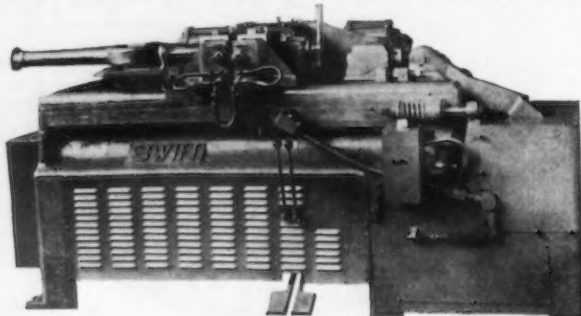
The battle for markets is being fought today in the board hammer shops by multiple-cavity dies, more accurately cut from better die steels and with consequent longer runs. Ingenuity in die design is one avenue of approach. Better sizing is being obtained by coining and alert shops are installing this type of equipment. Better finish quality is being met by sandblasting, shotblasting, tumbling and pickling. Shop costs are being cut by pushing equipment to capacity. Many jobbing shops make it the practice to run their hammers two or three tricks a day and to really run them. They clamp down the treadle and make every stroke count. By the time the hammerman has pulled the forging from the finishing cavity, the heater has pushed the blank in the breaker side of the die. Increases of 100 per cent in labor efficiency have been obtained in this way. Machines last only three or four years under this sort of punishment, but it pays on a cost-per-pound basis and automatically takes care of the obsolescence factor — notoriously neglected in most custom jobbing forge shops.

#### Plastics

Molded plastics have continued to gain in favor in the past year

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and the uses to which this material has been put have been extended. Custom molders have gained ground principally at the expense of die casters and stamping plants. Particularly where color and permanent, attractive finish are important have plastics gained. The thermal resistivity of the plastics gives them a warmth to the touch of human hands and their dielec-

tric properties make them adaptable as inclosures for electrical parts. Plastics are going into places one would hardly have dreamed of a few years back. It would not occur to the average engineer that refrigerator cabinet legs could be made cheaper in a plastic than in a stamping. Yet such is the case because the plastic comes out of the mold ready for

the job without further finishing being required.

A leaf might well be taken from the notebook of the plastic molders. Because there is an artistic appeal in a plastic, the leading companies generally engage the services of a well-known commercial designer, either for the job or on a retainer basis, when a new object is being pioneered. The X-Ray film projector illustrated, for example, was designed by Jean Otis Reinecke,



**T**HE Burton X-ray projector was designed by Barnes & Reinecke, industrial stylists, who specified molded plastics not only for their heat and electrical insulating properties, but also for fine appearance. Hood and lens housing are of Bakelite.

*Photo by courtesy of Chicago Molded Products Corp.*

an industrial designer. It is an entirely new product, but the hood and lens housing might well have been made of japanned stampings in another day. For a piece of apparatus that goes into a dental office the design is simple and dignified and its general tone is in keeping with its surroundings. The material is Bakelite.

## Thermo-Plastics

Thermo-plastics, such as cellulose acetate, have come up fast in the past year and are due to gain greater ground in 1937 because of

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their horn-like toughness, uniform texture, high luster and unlimited range of transparent or opaque color. Some very beautiful effects have been obtained by mixing colloidal metal with the material. Such plastics are molded merely by the application of heat and pressure and there is no chemical change during the process such as occurs in curing the phenolic and urea plastics. Because of these properties, thermo-plastics lend themselves to injection or extrusion molding, as well as to compression molding common to all the plastics. High production through increased speed of operation is the primary advantage of injection molding and is the factor that will give this material further competitive advantage over other non-plastic materials. Even in the latter, production time is shorter than for other plastics since no time must be allowed for chemical change. The elapsed time is determined by the period required first to heat the die, then to cool it. In injection mold-

ing, the heated raw material is shot directly into a cold mold. Time can be cut from a 6-sec. cycle for a compression mold to  $\frac{1}{4}$  sec. on an injection mold.

So far the process has been limited to light pieces—1 to  $1\frac{1}{2}$  oz.—and 8 oz. is the experimental limit at present.

There are all kinds of possibilities available in this direction. For one thing, metal cores can be covered by injection molding, thus combining the strength of metal with the beauty of the plastic. In Australia, window regulator handles have been molded over die cast cores, and in this country at the present time experiments are being conducted in injecting molding cellulose acetate around the metal core for an automobile steering wheel. Compression molds of steel core steering wheels are standard on a half dozen cars this year.

#### Combining Metals and Plastics

Possibilities of steel cores and various metal inserts lead to op-

portunities for other contract metal-working shops to tie in with the inevitable swing toward it. Several years ago one progressive stamping company saw the necessity for metal inserts in plastics and deliberately canvassed all the custom molders. This concern got in on the ground floor and as a result is enjoying a regular flow of inquiries and business from this source. Screw machine product shops have done the same thing, for all threaded sections are in the form of brass or steel inserts. The best hedge of all is to be set to carry on a variety of work. As a matter of fact, there are a number of contract shops supplying stampings, die castings, plastics or screw machine products or a combination of them in a component part. Furthermore, companies that have been making die casting machines are now building injection molding machinery as well—and selling them to die casting shops as well as to custom molders.

Certainly in the automotive field,

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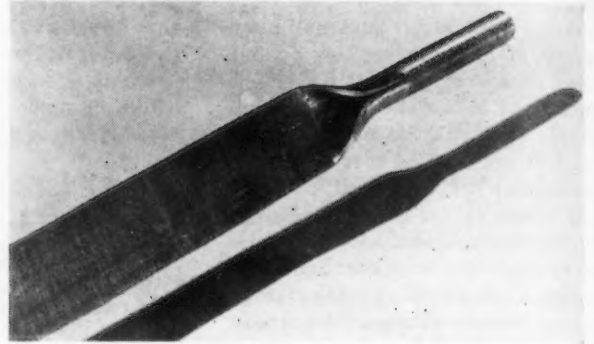
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Mount Vernon New York

the trend is toward the use of more plastics and the custom molders are going after more pieces every day that are now made in metal. Garnish molding is a case in point, and today interior window molding is being made in the form of a plastic, at least experimentally. This heretofore has been a steel specialty handled by contract shops that are equipped to transfer grain effects to metal. Warmth to the touch is one of the arguments in favor of the plastic part. This is merely another example of one of the many ways in which design changes are being fostered by parts suppliers who are alert to conversion possibilities.

It is a question of dog eat dog all along the line. Die castings replace stampings and molded products replace the die castings. Often the pendulum swings to the other way when the parts supplier gets out and pushes. An automobile company recently called for a die casting because of the intricacy of the piece and because the work

IN place of a forging riveted to a strap the Toledo Stamping Co. has curled the end of the gas tank strap and threaded it directly. Thus the conversion process goes on fostered by competition.



could be started faster at the beginning of a model season. There is always a supply of zinc on hand in a die casting plant, whereas it may be a matter of weeks for a stamping plant to get its steel after the sizes are known. Besides, only one die need be made for a die casting, in place of three or more for a difficult drawn part.

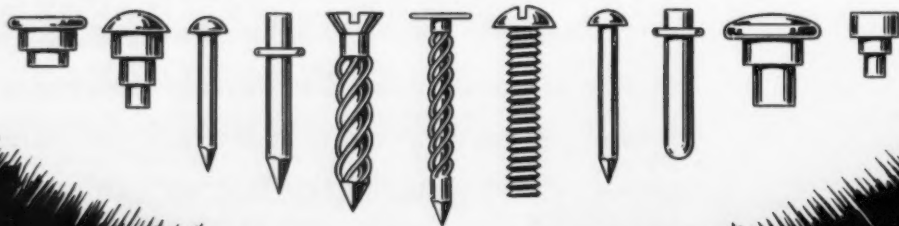
Yet after that particular job was in production a clever stamping shop engineer came along and showed how the apparently impos-

sible could be done, through his specialized knowledge of the cold flow of metal. In fact, in this instance the buyer's own production engineers asked this particular vendor to apply his brains to the job in order to cut down losses from breakage of die castings during assembly. The same company has also converted a die cast tail light bracket into a stamping because of the difficulty of riveting a 2-piece die casting together.

Out of this struggle for markets

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is bound to come a better definition of the field of use of each material. The harder the contract shops work toward this end, the sooner this desirable objective will be reached.

The general acceptance of improved methods of cost finding, in suppliers' plants as well as the plants of buyers of parts, has greatly improved the situation from the economic standpoint. Today, the parts supplier, whether of standard or special requirements, is not likely to accept business below cost.

Twenty years ago, or even fifteen, this was not so. With contract foundries, for example, taking work at a flat cost of so many cents per pound, the "smart" buyer of those days was inclined to reduce his own foundry costs by sending out for bids on the intricately cored light-weight shapes that might run as high, in cost, as 8 or 10c. a lb. If he could get these from a supplier who did not know his costs for 2 to 3c. a lb., he considered himself all to the good. Unfortunately, however, this practice was tough for the suppliers and, if there was enough of it, some of them went out of business.

#### Knowing Costs Important

The same thing was true of screw machine parts. I have heard of an instance, well verified, of a machinery maker who sent out some 10 or 12 identical specifications to makers of screw machine products some years ago for parts which comprised a portion of his product. The bids which were returned varied by as much as 50 per cent, which clearly indicated that someone was willing to work for less than nothing.

Of course, even in those days, there were concerns which did not stoop to such practices and which believed that letting business at a loss was poor economic practice. They did not accept the principle of "caveat vendor" for suppliers any more than they accepted the principle of "caveat emptor" for themselves. However, there were some exceptions and these adopted the motto, "devil take the hindmost," then as there are, unfortunately, now.

Today, however, it is difficult for the unscrupulous buyer to "put one over" on a wide-awake supplier. Suppliers know their costs or, if they do not, they go out of

business, which is where such suppliers belong. They know that the first principle of business is to make a profit. This applies to development work as well as to production runs. It is a much healthier condition for all concerned and especially for the suppliers.

Is the supplier an essential and permanent part of our industrial system? The answer is something that the law of supply and de-

mand and the law of the survival of the fittest will determine. The supplier exists by the right of specialized supremacy; of being able to do some one or few things better or to make them at less cost than can the concern with many things to make and do. So long as he does this, he will have a place in the economic sun, and let us hope that it continues to be an enviable one.

## HE WANTED IMPROVEMENT



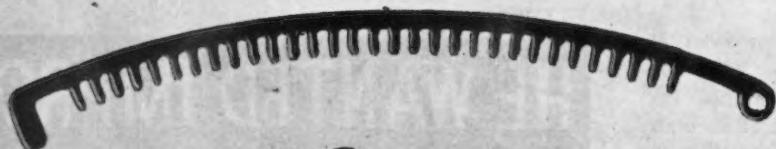
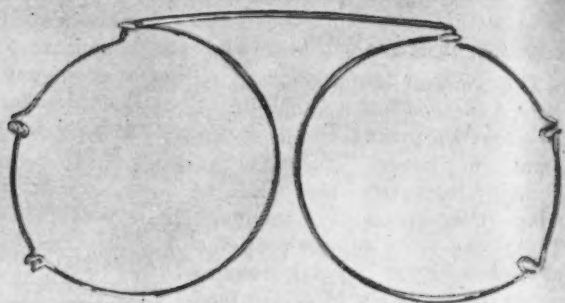
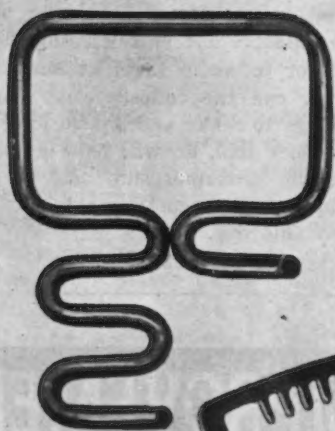
**T**HE inclinator step illustrated is of pressed steel  $\frac{1}{8}$ " thick;  $15'' \times 15\frac{1}{2}'' \times 3\frac{3}{8}''$  high. The welded end lugs provide the necessary strength, at less cost than is feasible by any other method.

This is typical of what Parish engineers are able to accomplish, by a skillful combination of stamping and welding, to provide better parts of improved appearance and lowered final cost.

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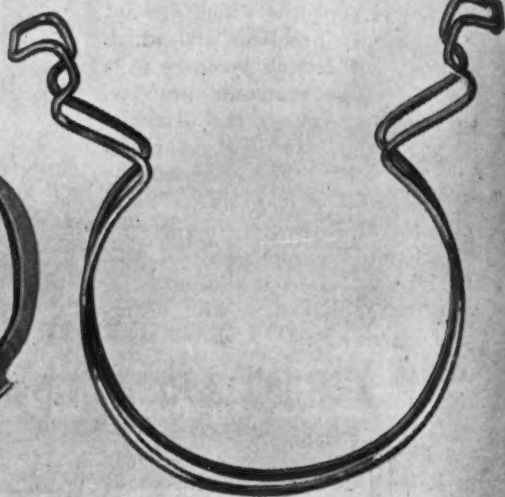
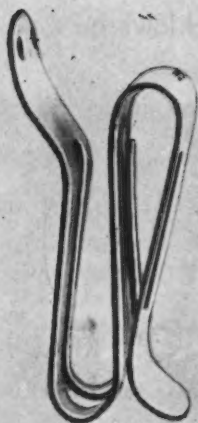
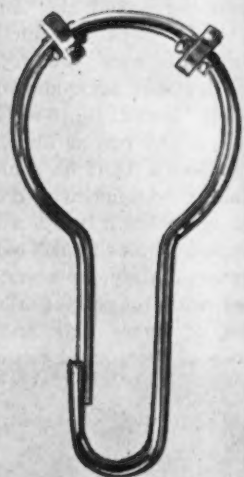
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# METAL FINISHING

*Progress is recorded in electroplating,  
lacquers and paints, rust-proofing,  
cleaning and special finishes as well  
as in equipment for finishing.*

By HERBERT R. SIMONDS

*Vice-President, Metals and  
Plastics Bureau  
Rockefeller Center, New York*

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WHEN General Motors revised its metal finishing specifications during the past year, it doubled the previous minimum thickness for electroplated coats and in so doing expressed vividly and clearly the new attitude of both manufacturer and purchaser toward metal finishing. A widespread demand for better finish and improved means for producing better finish were two striking features of the past year's progress in the metal industry.

"Does metal have to corrode?" asks the public, and the manufac-

turer, aware of the increasing threat of plastics, glass and other non-corroding materials, is quick to answer, "No, all metals may be surfaced to withstand corrosion." "Does metal have to be dull and colorless?" asks the public and the answer is, "No, metal may be colored all colors of the rainbow and may be coated to give almost any conceivable effect."

Ford retained the strength and ruggedness of metal for automobile door handles when he dipped die castings into cellulose acetate and so gave them a pleasing plastic coating. By a reversal of that process others have taken shells made of plastic and have filled them with metal by injection die casting.

In reviewing metal finishing

progress for 1936, one is forced to admit that the number of new developments does not make as impressive a list as it did for 1935. However, the past year perhaps was more noteworthy than any previous year in that there was general acceptance by industry of the importance of proper finish. Sales studies were completed to demonstrate conclusively the dollars and cents value of attractive appearance and the almost sure loss of good-will resulting from premature corrosion.

## Fine Finish Gains Acceptance

In line with the new attitude toward finish, many metal-working plants have redesigned and rebuilt finishing equipment to bring it into production harmony with



in rhodium plating technique and brush plating of nickel and chromium.

#### A Transition Year

The year, according to Dr. Colin G. Fink, of Columbia, will be viewed as a transition period between the research developments of 1934 and 1935, and the practical applications of 1937. Nevertheless, he reports great activity in electrochemical laboratories throughout the country and considerable accomplishment. "Outstanding," he says, "was the perfection of the technique of manganese plating on steel. Such plated coatings have many features; they are very hard, are easily colored, afford good corrosion protection and perhaps most important, they are easily and simply applied." Dr. Fink predicts for 1937 the placing of aluminum plated steel

#### ABOVE

**A**IRPLANES in many cases have not gone into the mass production methods of automobiles. This shows a small installation for rust-proofing airplane cylinders.

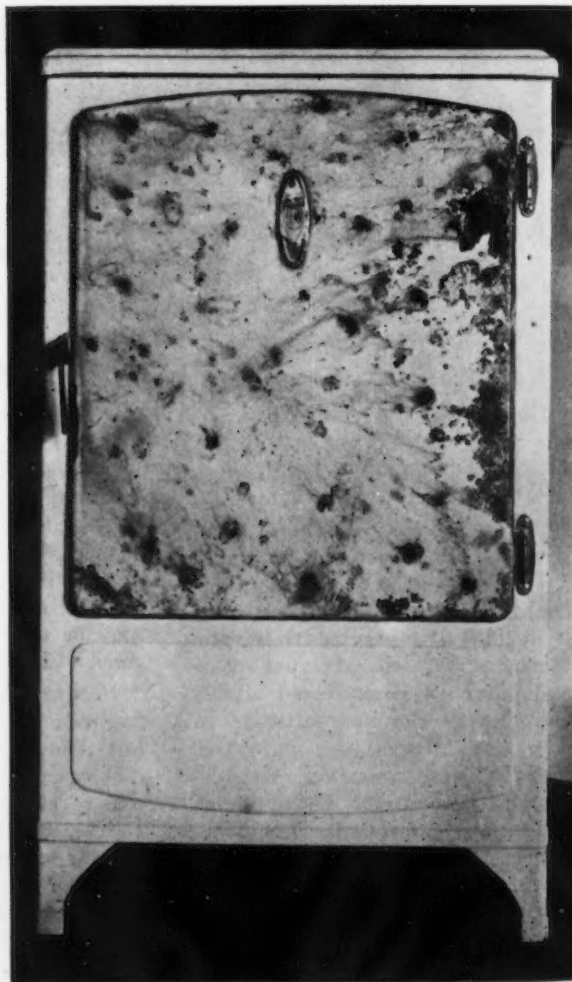
*Courtesy American Chemical Paint Co.*

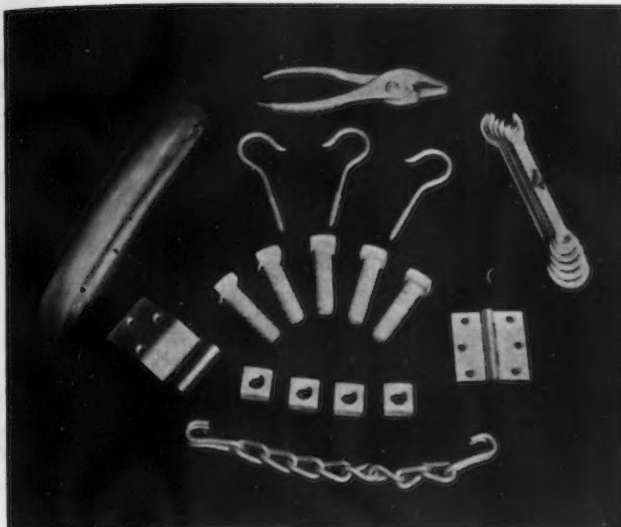
other fabricating processes. Equipment manufacturers on their part turned their attention to more automatic, more self-contained and more "in-line" designs of such machines as picklers, enamel sprayers, metal parts cleaners and electroplaters. An interesting example of the value of new design in equipment is told by engineers of the Bullard-Dunn Division of the Bullard Co., Bridgeport, Conn. This division sponsors an electro-descaling process which has been described in detail in *THE IRON AGE*. By it, scale is electrochemically lifted from parts dipped in a solution and the underlying base metal simultaneously is electroplated. Introduction of this process to industry has not progressed as rapidly as hoped, and to help the situation the company developed during 1936 an automatic machine of the type shown in an accompanying illustration, and in so doing apparently solved the problem, for in November the sales report on this equipment was "behind on orders."

The Hanson-Van Winkle-Munning Co., when asked what it thought was the most important development in metal finishing in 1936, stated, "continuous plating, cleaning and pickling of steel strip." Other replies to this same question have mentioned electrolytic coloring, new synthetic lacquers, asphalt base paints, progress

#### AT RIGHT

**T**HIS shows what happens when a refrigerator door is not properly finished. The cabinet was electrogranodized before enameling but the door was not.





#### AT LEFT

**T**HESE familiar metal products are shown coated with a bright zinc plate by a process brought to perfection during 1936.

*Courtesy R. & H. Chemicals Department of DuPont*

Yet on closer examination, it appears evident that these collateral developments are interdependent. The modern refrigerator, for instance, would be impossible except for the availability of metal finishes of fairly recent development. The same situation exists with such other metal products as washing machines, permanent waving apparatus and colorful stoves, and in industry, metal containers for acids and other chemicals, long life dies and continuous pickling machines.

#### Production Progress

In service as well as appearance, the value of proper finish is being recognized. Thus one manu-

strip on the market and the development of a satisfactory method of coloring chromium plate.

J. O. J. Shellenberger, of the American Chemical Paint Co., agrees with Dr. Fink that much interesting work is now in progress in research laboratories. He states, "The simplicity, speed and economy of spray-granodizing have suggested that steel strips and sheets may be thus coated in the steel mills and sold as rust-proof metal. This is still in the experimental stage, but if successful, and we have every reason to believe it will be, it should be the forerunner of a new type of steel mill service."

Speaking more generally, he continues, "From our experience in the last year, it seems that the metal fabricating industry is definitely convinced that more attractive and more durable finishes are leading factors in determining increased sales. We have found a more widespread interest in the modern finishing products and processes than ever before, and this interest, which heretofore was mainly derived from the automotive industry and a few similar large production factors, seems to have permeated down to the small fabricator, who with the processes now available is able to finish his products in a fashion enabling him to compete effectively in this respect with the largest manufacturers."

It seems coincidental that with the increase in general awareness of the importance of metal finish, there has occurred a striking increase in the number of products requiring good finishing properties.



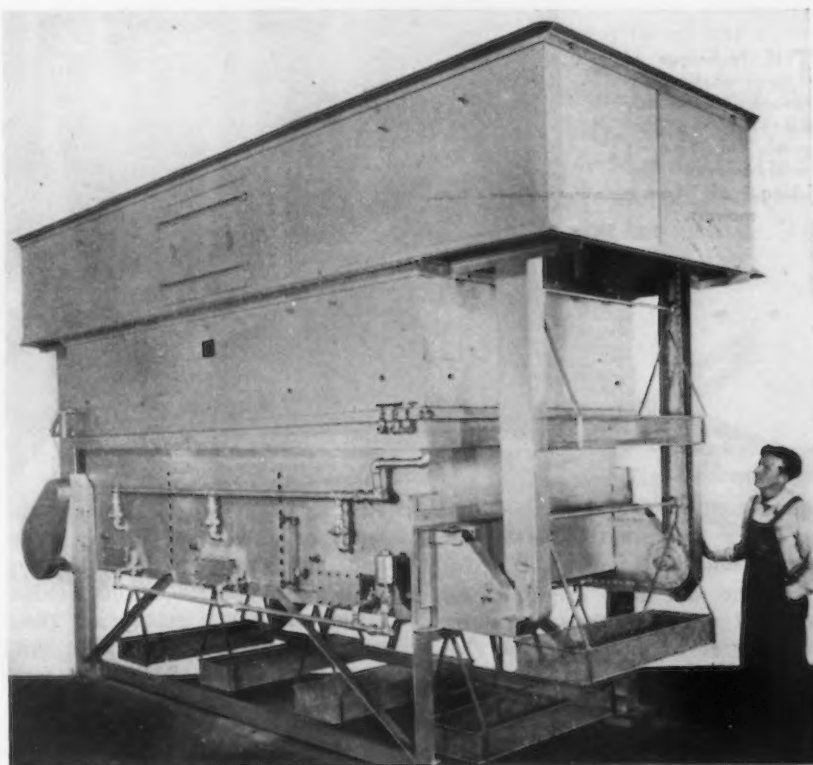
#### AT LEFT

**T**HIS photomicrograph shows what happens with poor painting technique. For success, not only must the paint be right but also the condition of the underlying metal.

*Courtesy Pittsburgh Plate Glass Co.*

#### BELOW

**A** DOUBLE-END loading and unloading three tank Blakeslee automatic degreaser for production cleaning of metal stampings, screw machine and other parts.

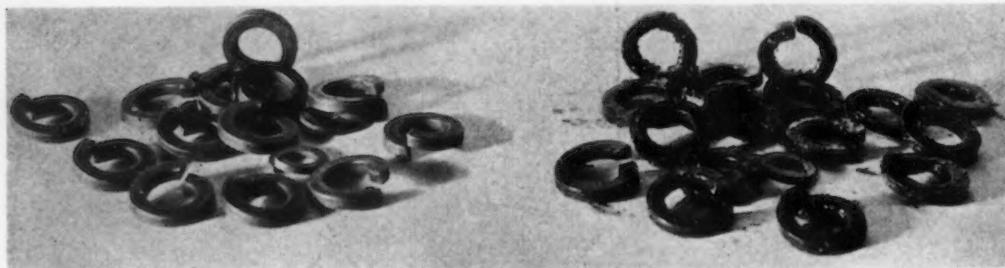


facturer of ball bearings is advertising "mirror finish," and United Chromium, Inc., reports a particularly large increase during 1936 in chromium plating for wear resistance. New applications include the surfacing of dies used in making plastics, of drawing dies for pipe, of parts for calculating ma-

1936 along with the general improvement throughout the metal-working industry.

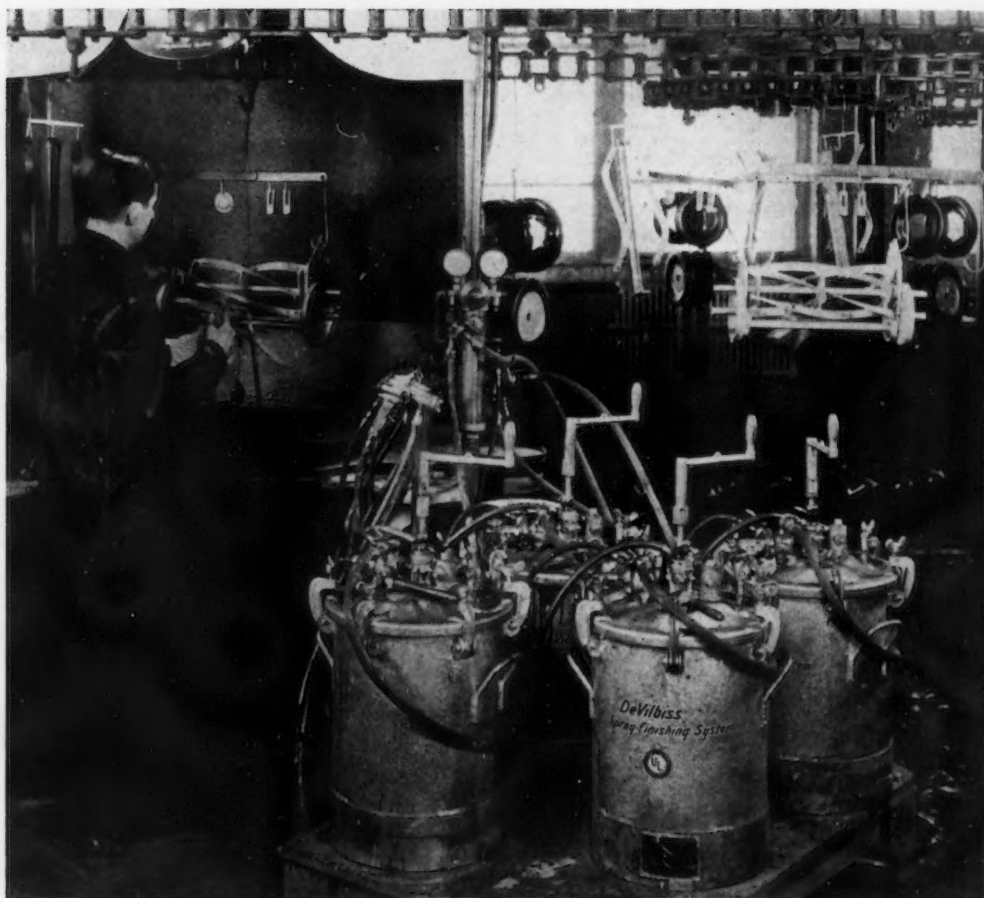
Figures of the actual increase in the divisions reported on by the Bureau of the Census are not yet available, but an estimate based on earlier reports gives the value of electro silver-plated ware for

various coatings in different parts of the country continued to pile up valuable data for analysis, and considerable work toward standardization of finishes was done in committees. The subject is complicated and it probably will be some years before any complete standards can be adopted, espe-



**A**N unretouched photograph of lock washers before and after cleaning. The problem was to remove completely heavy oil and scale in one trip through an automatic washing machine. The solution used was Metso 66 at 190 deg. F., with no rinse.

*Courtesy Philadelphia Quartz Co.*



THE technique of spray coating advanced enormously during the past year. This shows multi-colored finishing of lawn mowers.

chines and of several parts subject to heavy wear in the textile machine field.

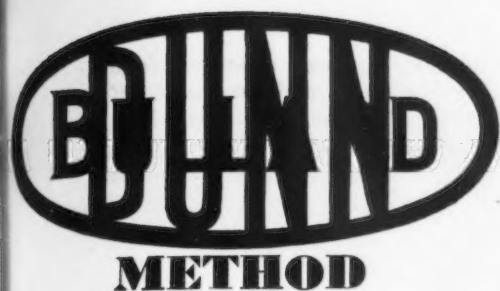
Bright zinc and bright nickel, spurred on by the continuing scarcity of cadmium for the electroplater, made long strides during the past year and activity in nearly all branches of the metal-finishing field improved during

1936 as about \$40,000,000, and the value of galvanized sheets, plates and strips produced by rolling mills as about \$80,000,000. Other estimates are: galvanized iron household ware, \$8,000,000; vitreous enameling, \$4,000,000, and japanning, lacquering, and paint enameling, \$2,000,000.

Tests of corrosion resistance of

cially in view of the new developments each year which often alter basic conditions. A few of the chief variables desired for a finish and for which standards are needed are thickness, specific gravity, resistance to corrosion, color, gloss, resistance to abrasion and surface texture.

Advance in the technique of



## ELECTRO-CHEMICAL DESCALING of METALS

Complete removal of scale from metal parts is accomplished by the Bullard-Dunn Process on both external and internal surfaces simultaneously.

The electric deposition of a protective metal film simultaneously with scale removal eliminates pitting, etching or other damage to the base metal surface under the scale layer.

We invite your questions on this Process. Send or Bring samples of your work for demonstration processing.

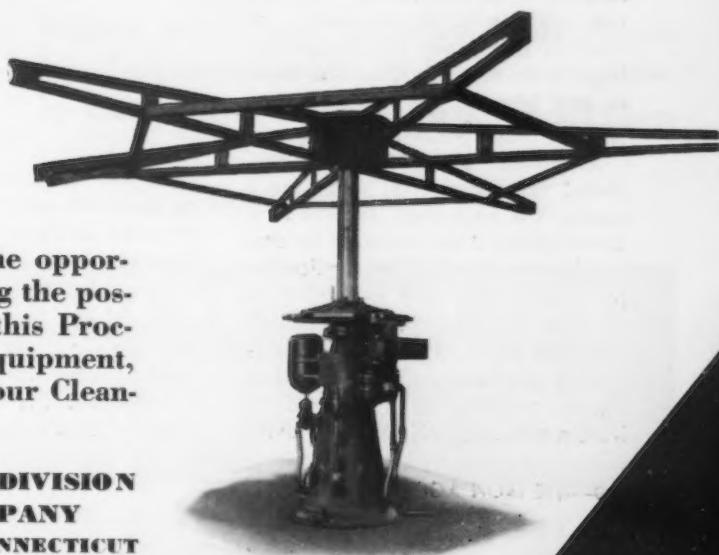
**AS  
APPLIED  
TO  
PRODUCTION  
WORK**

The Equipment needed for the operation of the Bullard-Dunn Electro-Chemical Descaling Process is similar to that required for Electro-Plating.

For average volumes of work the tanks may be served manually. However, for the larger volumes, the Bullard-Dunn full automatic station type rotary conveyor affords more Efficient and Economical material handling. This machine is illustrated herewith.

May we have the opportunity of outlining the possibilities of either this Process, the conveyor Equipment, or both as applied to your Cleaning Problems.

**BULLARD-DUNN PROCESS DIVISION  
of THE BULLARD COMPANY  
BRIDGEPORT CONNECTICUT**



decorative lacquering and plating was made, particularly in the application of multi-colored lacquer bands in one operation and the combination of lacquers and electrodeposited coatings in mass production. A special rubber coating was developed for spraying on to surfaces which are to be masked against plating or against the ap-

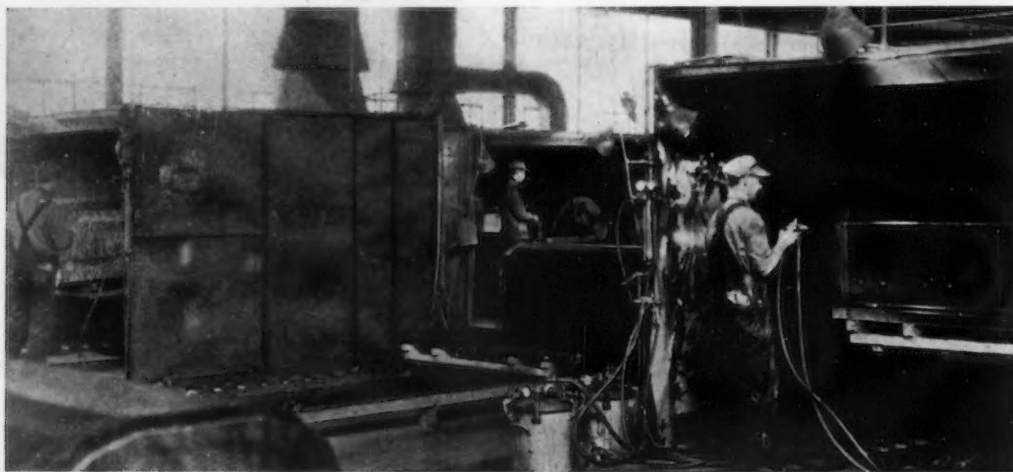
80 per cent. The highest reflectivity for any surface is claimed for polished rhodium plate over chromium. Such reflectors have been used for aviation beacons.

Tin plate has held its own in the surprising progress of other plated coatings. After considerable hesitancy a year or more ago the public has finally accepted the tin can

in thin coatings deposited from alkaline baths and the results of an investigation in this field have been published by the International Tin Research and Development Council.

### Depositing Iron

L. E. Eckelmann, of the Pyrene Mfg. Co., reporting on plating de-



SPRAY coating apparatus is now important equipment in nearly all repair and overhaul shops.

Courtesy DeVilbiss Co.

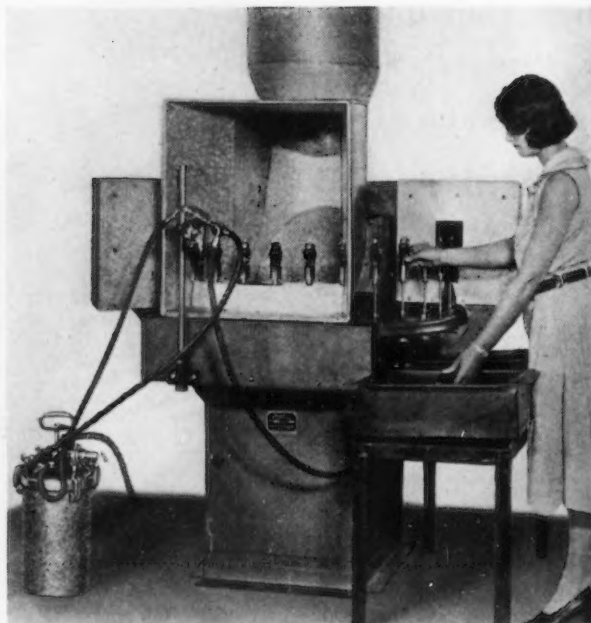
plication of one particular color. This protective coating is said to be readily stripped off after its masking effect has served its purpose.

### Electroplating

BOTH bright zinc and bright nickel-plating processes were improved and extended during the past year and new developments now in the laboratory are expected to appear commercially this year. Manufacturers have confirmed the platers' statement that approximately 10 per cent in overall cost of chromium plating may be saved by the use of bright nickel. In the case of bright zinc, its extended use admittedly is dependent at least in part upon the continuing high price of cadmium. The ratio of cost between the two is 7 or 8 to 1 in favor of zinc.

Aluminum plate on steel, predicted for commercial appearance during the past year, is still in a development state although several notable instances of its application have appeared, one of which is seen in the manufacture of high reflecting mirrors, the plated aluminum surfaces of which when highly polished are reported to have a reflecting efficiency of about

MULTI-COLOR lacquering of small parts has passed into the one-operation automatic field.

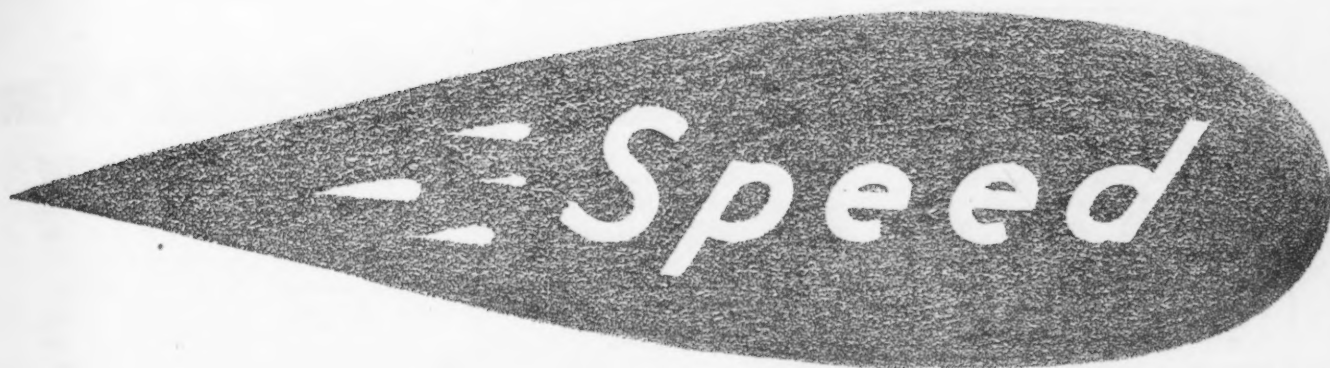


as a beer container and heavy increased tonnage in tin plate and tin strip consumption has resulted. Several other new uses for tin have been reported.

An English patent was taken out covering an improvement in electrodeposition of tin. By this new method it is claimed the porosity is greatly reduced, especially

developments of the year, refers to extended application of his company's bright nickel process. He mentions some installations of the full automatic type permitting a direct flow of work right through the chromium plating without removal for polishing after the nickel coating.

He reports also on the extension



*in Cleaning Your Products Is Assured by*

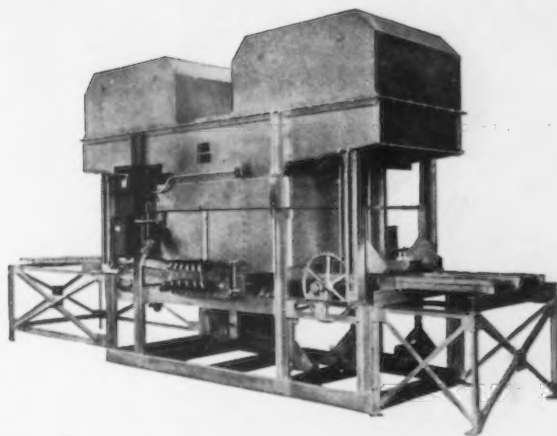
## DETREX METHODS

Detrex Solvent Degreasing is the most positive and efficient method for removing oil, grease, and other contamination from all kinds of metal products.

This process makes use of scientifically designed Degreasing Machines, and Perm-A-Clor or Triad Safety Solvents. It is producing superior cleaning results in metal working and finishing plants throughout the country.

Detrex Degreasing meets the demand for modern methods and increased production speeds. Less floor space and time are required for this improved process . . . And lower cost per unit cleaned, results.

Detrex Solvent Degreasing is the most widely preferred method of cleaning



*Electrically heated, completely automatic Detrex Degreaser, used for the production cleaning of metal parts.*

steel and non-ferrous metal parts prior to rust-proofing, all kinds of finishing, heat treating, pickling, and inspection.

It is simple and most effective.

Write for information on our complete line of standard and specially designed machines, ranging from small, hand-operated units to large, completely automatic, conveyORIZED machines.

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of the company's pyron process, which is essentially a means of rapidly depositing a ferrous alloy on steel to build up worn parts such as crankshafts, pistons, gages and cams. The rate of deposition may be 0.03 in. per hr., which it is said permits the rebuilding of the average worn machine part in one working day. Other features claimed for this process are: no warping, a perfect bond between

base metal and coating, possibility of carburizing or hardening the coating in any conventional way, and low cost.

Many specialized methods of coating metal with metal fall outside the heading of plating but some may be mentioned briefly here. Research work continued during the year in several new types of metal spraying and considerable promise is held out for

the method which sprays semi-molten particles on to the base metal through a reducing flame or reducing gas atmosphere.

A method known as Chromizing has extended its use during the year. This consists essentially in placing powdered chromium and other compounds with steel bars in containers and in heating the combination until the chromium forms a coat on the bar. Afterward the bars may be rolled into strip or drawn into wire and it is claimed the resultant surface has characteristics similar to those of standard stainless steel.

### "Sputtering"

In 1935 the Snyder process of plating on non-conducting material was developed and use of this process was extended during 1936. A new and somewhat similar process developed during 1936 is known as sputtering. The object to be coated is placed between electrodes in a vacuum. The electrodes are made of the metal to be deposited. A high-frequency current is used and the molecules of metal are deposited as an extremely thin film on the object. This film then serves as a base for electroplating in the orthodox manner.

Cleaning and pickling which are closely associated with plating are considered elsewhere in this review but a method for preventing pitting of nickel deposits may be mentioned here.

The Plating Products Co. has developed a wetting solution which it calls Stop-Pit which is essentially an addition agent to standard nickel-plating solutions intended to reduce the surface tension of such solutions. The result is said to be more complete wetting and less adherence of any foreign matter to the metal surface. It also is claimed that hydrogen bubbles forming on the surface of the metal break away while small and that this continuous removal of the small bubbles as they form is a chief means of preventing pitting.

### A White Brass

Among the new plating processes of the year was the white brass plate of the Alrose Chemical Co. This new coating is claimed to be as white as silver, to be non-tarnishing and easily controlled. Platers are told that the process can be easily added to their plant



## Tied Down by Custom?

No matter what bonding or rust-prevention process your company has been using these past years, you will want to look into this new Marks Bond process.

Your present equipment may be used. Saves time on processing. This bonding process has proven effective under many commercial tests and will give a satisfactory coating in 30 seconds. • It

permits a saving on equipment space.

- Saves on fuel and heating of tanks, requiring a solution of only 140 to 160 degrees.
- Sludge practically eliminated.
- Has passed salt spray and humidity tests.
- Gives controlled etching—light or heavy.
- Has been officially approved by several of Detroit's largest industrial plants.

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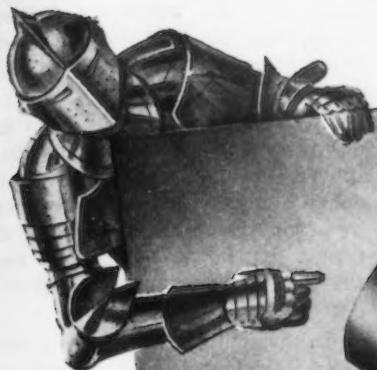
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## FLEXIBILITY AND ADHESION



A simple hard banging together of steel tubes coated with Blue Knight Flexible Finishes demonstrates . . . (1) Resistance to Abuse, (2) No Chipping, No Flaking, No Peeling!

## Six words WORTH KNOWING

**NO CHIPPING! NO FLAKING! NO PEELING!** The dollar value of these six words is the most significant interpretation of two vital components of Blue Knight Flexible Finishes . . . permanent Flexibility and permanent Adhesion.

Roxalin products have long been known (since 1924) for possessing these *finish-life* factors to an outstanding degree. And they are the foundation characteristics of a long list of Blue Knight surface coatings which are engineered for specific performance. (See Column at right.)

See our display in the Exhibition Quarters of Metals & Plastics Bureau, 3rd Floor, International Building, Rockefeller Center, New York City.

A wide safety zone of Flexibility and Adhesion acts as a cost and service safeguard. It eliminates rejects and refinishing in fabricating and assembly operations. In shipping and warehousing, rough or abusive handling does not result in marred finishes. On aging, either in storage or in dealer's hands, no brittling of the finish occurs.

When we refer to **NO CHIPPING, NO FLAKING, NO PEELING . . .** it's just another way of saying, "*To do its job, a surface coating MUST REMAIN INTACT!*"

# Plus!

### Corrosion-Resistance A Technical Triumph

A long-lived and fully flexible **BLUE KNIGHT** finish known as **ROXYN-C** is now in successful commercial operation producing films (*in clear and all colors*) that are impermeable to corrosive influences, such as:

*Constant cycles of Cold and Heat; Humidity, Brine, Refrigerant Fumes; Alkaline Washing Compounds; Pure Alcohol; Perspiration.*

**ON REQUEST** an interesting printed summary of **ROXYN-C** will be mailed to your attention. Numerous production advantages are detailed.

### Controlled Wrinkling In Texture Finishes

**RINCON-TROL** is a widely used Blue Knight texture finish, which produces no "fat edges," irrespective of thickness or thinness of coats.

A shining illustration of the adaptability of **RINCON-TROL** is the large surface coating of an air-conditioning unit measuring 9'x5"x2' . . . heretofore considered a feat impossible to accomplish with complete success. For small surfaces, such as small die-castings, typewriters, car radios, heaters, this Blue Knight controlled - wrinkle finish is outstanding, especially in view of its high resistance (*impermeability*) to the corrosive effects of perspiration.

**ON REQUEST** a die-casting or panel (*state which*) finished with **RINCON-TROL** will be mailed to your attention. You will see for yourself the rich effect of the texture, and the complete freedom from "fat edges."

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# ROXALIN Flexible FINISHES

**CELLULOSE & SYNTHETIC TYPES  
ENGINEERED FOR SPECIFIC PERFORMANCE**

procedure. A small steel tank serves to hold the solution and also to act as an anode. The bath operates at a temperature of 140 deg. to 175 deg. F. at a current density of 25 amp. per sq. ft. No after-buffing of plated work is required and a mirror finish is claimed for polished work after a two-hour plating period. The plate is a three metal alloy which adheres well to almost any base metal.

The Grasselli Division of DuPont reports improvement and standardization of its molybdenum bright zinc plate. A bulletin has recently been issued giving this plate the trade name Zin-o-lyte and describing its operation both in still plating and barrel plating.

Another bright zinc process is reported by the R & H Chemical Division of DuPont. This consists of a brightening agent introduced into regular plating solutions with no other changes in plating technique called for. It is said to be particularly adaptable to barrel plating processes.

As technique in zinc plating improves, the process is seen to come closer and closer in essential features to cadmium plating and one by one the different objections to zinc have been overcome. Many investigators now claim that for all practical purposes zinc can be

deposited in the same thickness and in the same time as cadmium. The higher current density required for zinc is offset by the lower cost of zinc anodes and zinc solutions.

The J. C. Miller Co. also has issued bulletins recently describing equipment and processes for bright zinc and bright nickel plating and the company states that it feels progress in these two processes forms the outstanding development in the field of metal finishing during the past year.

#### Pink Gold

An alloy plate giving a pink gold appearance is reported. This consists of nickel, palladium, gold and copper. One plater reports success with rhodium coating on silverware in a sulphate bath containing two grams of rhodium and a liter of water. This operates at 104 deg. F. with a current density of 5 amp. per sq. ft.

In the chromium plating situation, perhaps the most interesting development of the year was that on Dec. 7, the United States Circuit Court of Appeals for the Second Circuit reversed the decree of the lower Court which had held the Fink patent, United States patent No. 1,581,188, valid and infringed in a suit brought by United Chro-

mium, Inc., against General Motors Corp., New Departure Mfg. Co. and the Bassick Co.

It is understood that further steps will be taken by United Chromium, Inc., and that these are now being considered by its counsel.

A considerable improvement in design of anodes and plating auxiliaries has appeared. A current density meter is being used by some platers. With it the point of lowest density is determined and the plating time may be adjusted accordingly.

An attachment for anodes has been introduced. This consists of a container hung on a new anode and filled with scrap anodes. It is said to be a simple and efficient means of using up anode scrap.

Ball burnishing as an adjunct to the plating shop has increased in popularity. On small parts in bulk it is often possible by this means to replace the buffing operation between one electrodeposited coating and another.

Another place where ball burnishing is popular is in inlay and etching work. Certain parts after being sprayed with colored lacquer may then be ball burnished to remove the lacquer except on recessed surfaces where its decorative effect is desired.

(TO BE CONTINUED)

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# PLANT EQUIPMENT

*Suppliers of plant equipment now face a long period of increasing demand as the recovery march reaches the secondary lines.*

By ROGERS A. FISKE

*Western Editor, The Iron Age*

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GENERAL plant equipment demand like that for other industrial apparatus has profited greatly by the six lean years when sales curves lagged but research brains continued to function at top capacity. Many plant owners and managers suffering the pains of small sales have been forced in recent years to forego the pleasant duty of studying new developments and of seeing their dreams realized. The situation now is vastly improved. Pocketbooks are fatter and rising costs as well as consumer pressure make improvements all the more inviting. The urge to modernize is coming with a rush. Man power and plant

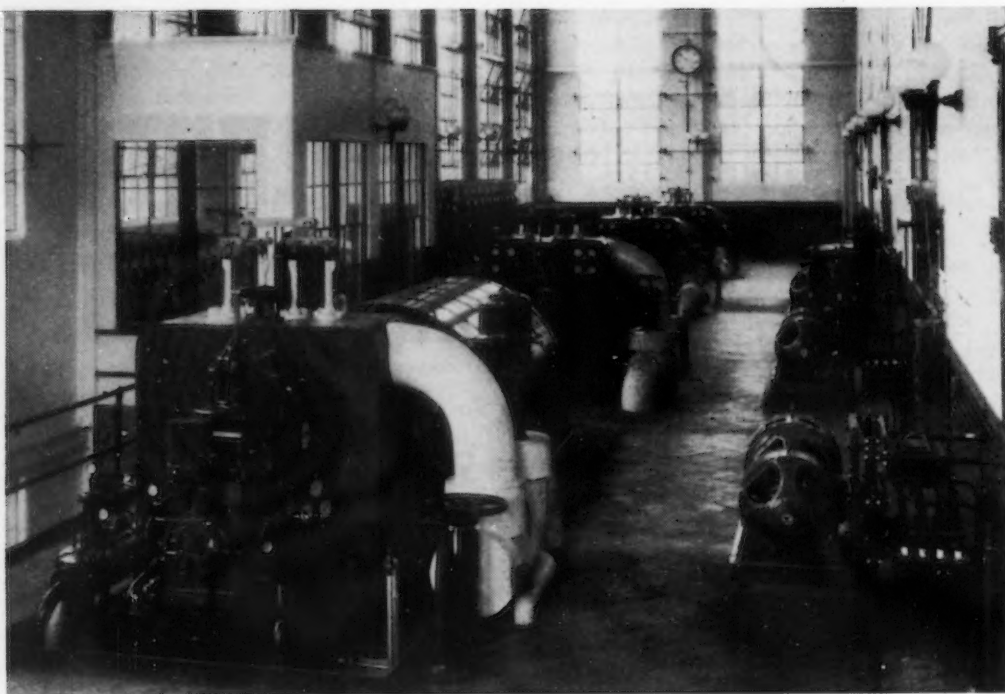
capacities are being taxed and deliveries are being pushed back. Therefore, it is a fair warning that in order to take prompt and urgent advantage of six years of development improvement, purchase plans should be put into practical operation without delay.

Primary among plant operation problems is that of power, which should be studied and solved on the basis of the economics covering each particular case. Availability of adequate condensing water, or the use of low-pressure steam for process work will often determine whether or not steam turbines, or steam engines will be most economical. Fair consideration must be given to the purchase of public utility power with boilers ready to take the heating load. Combinations of purchased and plant-generated power will usually bear close study, there being well de-

fined instances where well operated and efficient industrial plants can use off-peak purchased power to meet supplementary requirements at attractive cost figures.

## Gains on Prime Movers' Efficiency

Prime mover builders have not been idle during recent years to further improve the design and the efficiency of their units. These builders are available with excellent background and experience to contribute to studies of power problems. Boiler manufacturers have new and improved wares to offer which point to higher operating profits. Boiler plant accessory designers have not lagged and control instruments have stepped beyond anything dreamed of a few years ago. There have been imparted to these control devices not only added ruggedness and trustworthiness but greater accuracy



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**TURBO-GENERATORS** hold an important place in the design and operation of industrial powerplants.

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over far longer periods of time. They are offered in such wide variety and for so many purposes that power plant operation is at least semi-automatic and, therefore, many of the economies and practices of large plants have been passed down the line and are now available for the ordinary sized industrial power plant.

New industrial steam plants are turning to high-pressure steam, that is, 1200 lb. per sq. in., and to superheated steam of the order of 850 deg. F. Economies of the new high-pressure, high-superheat steam generating units may be

combined with the older-type, lower-pressure turbines by placing between the new boilers and the old turbines a top turbine which utilizes high pressure and delivers steam to the old units at the required pressure.

#### Small Stokers

Stokers, as such, are not new, but within the past few years special emphasis has been laid by numerous manufacturers upon the type of unit suitable for small installations of the order of 300 boiler horsepower and less. The foremost advantage of stoker fir-

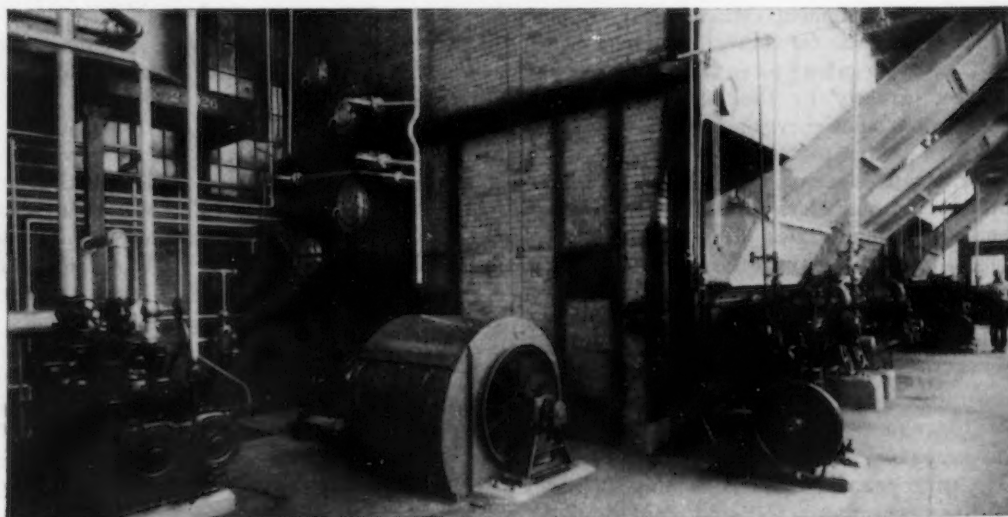
ing is economy, but other important considerations should be recognized. These are: uniform pressures and temperatures, smokeless combustion (of particular interest to industries located in or near residential areas), and increased capacity, a result often experienced when hand firing is changed to stoker firing.

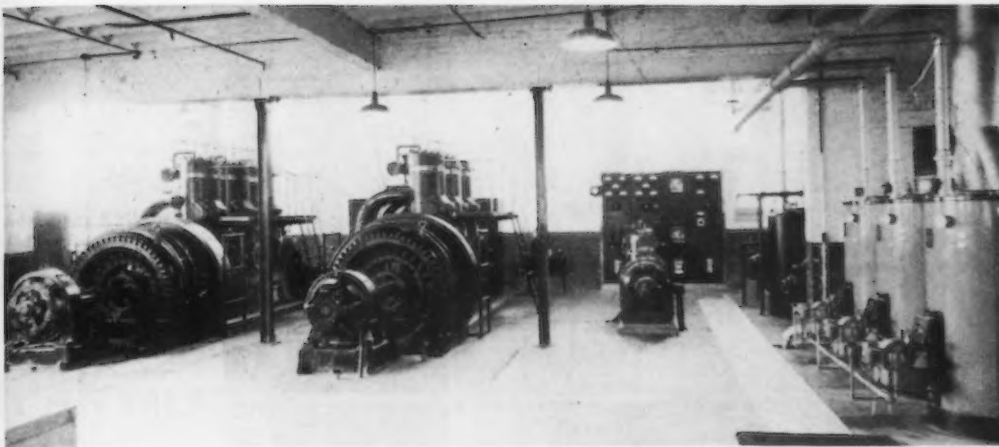
Economies to be realized are indicated by typical tests which show that a hand-fired boiler evaporating 7.75 lb. of water per lb. of \$6.00 coal recorded a fuel cost of \$3.28 per 1000 gal. of water evaporated. The installation of a

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**INDUSTRIAL** boiler plants can profitably make use of most, if not all, money saving appliances.

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**D**IESEL engines offer economies especially when heat is reclaimed from cooling water and exhaust gas.

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stoker using \$5.50 a ton coal resulted in a fuel cost of \$2.58 per 1000 gal. Further, the stoker-fired boiler averaged 161 per cent of rating and all the engineer's time and most of the fireman's time is now spent on maintenance and production work.

Constructional and control features of these stokers leave little to be desired. These stokers are protected by shear pins and overload cutouts. Shear pin alarms are available, as are automatic speed and air controls. All tried and proved combinations of coal handling and storage facilities are applicable to these installations as are standard practices for ash handling and removal. The extent

to which the small boiler plant can be modernized is only a matter of the economic aspects of the problem at hand.

#### Electronic Stoker Control

Electronic engineers have now made available a control which offers automatic heat with coal for commercial installations up to 300 hp. with temperatures held to within one degree. A device on the outside of the building, in connection with electronic tubes, automatically controls stoker operation. This control requires no adjustment after once being set. It has no moving parts, no bi-metallic strips and no contact-making thermostats.

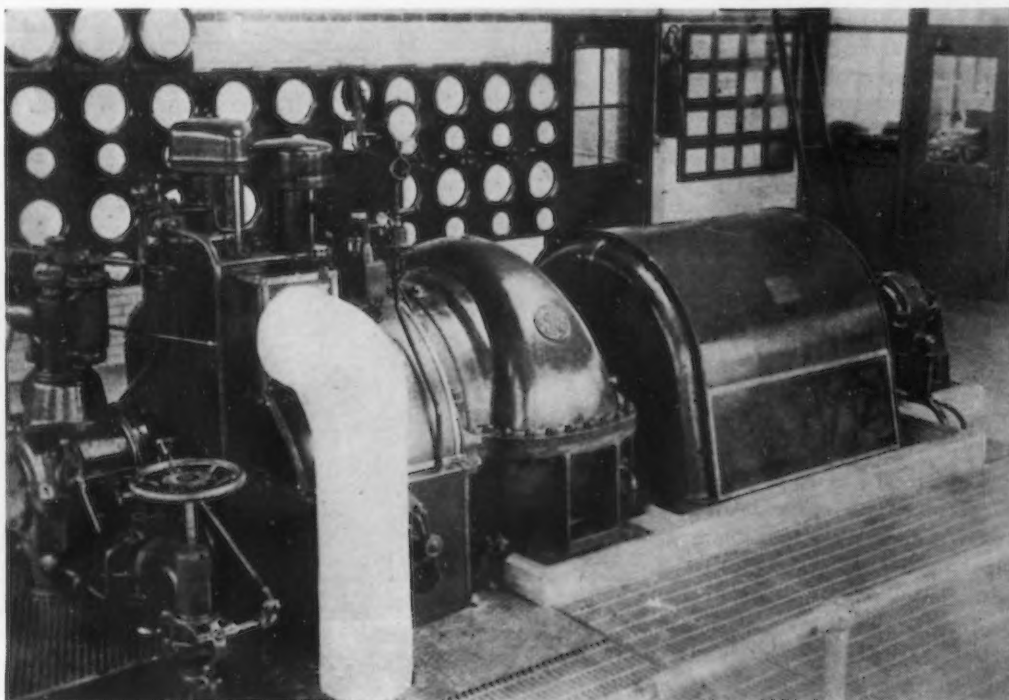
The spread of natural gas mains over much of the industrial area of the United States has brought this fuel into prominence for power uses as well as for general industrial consumption. Utility companies, forced to lay mains of economic size and having contracts with natural gas producers, have gone far in introducing the use of gas not only for year 'round use, but also for off-peak periods by application of special rates which often result in satisfying economies.

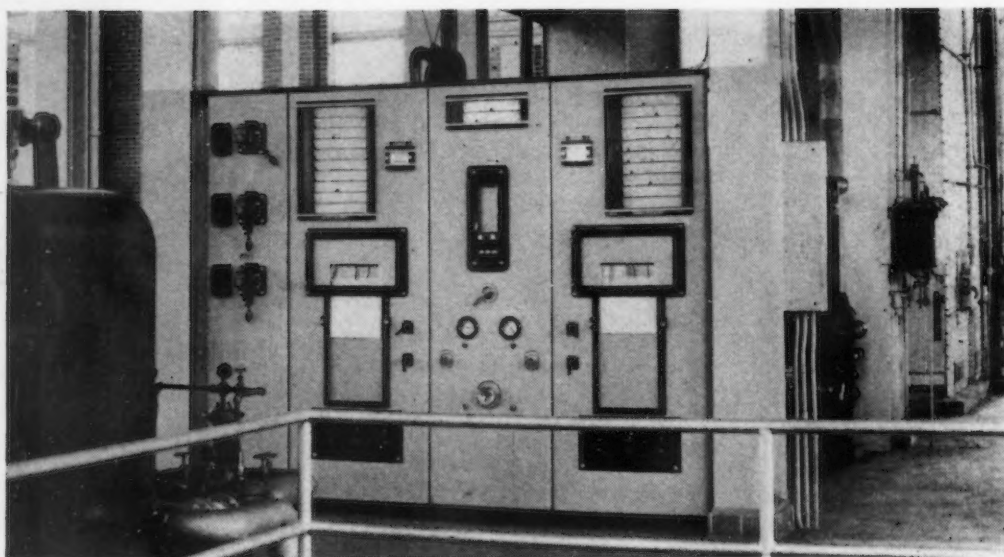
Acceptance of gas, as an industrial fuel, is shown by the fact that total sales for industrial and commercial purposes in 1935 were 3,000,000,000 cu. ft. based on

o o o

**A** 1000-KW. condensing — extraction steam turbine-generator set in an industrial plant.

o o o





POWER unit control instruments give accurate and dependable service.

530 heat units per cubic foot. This is equivalent to 65 million tons of coal.

#### Dual Equipment for Gas

As a general rule, the industrial off-peak season extends for seven months in the northern latitudes. It is during this period that many plants find the use of gas justifiable from the viewpoint of cost. The problem of dual equipment, used in installations where a switch from one fuel to another is necessary, has been solved. The usual changeover is from oil to gas, and in the late fall from gas back to oil. Some burner equipment is of the combination type, where a few minor adjustments and the opening and closing of several valves accomplishes the changeover, settings and controls being adapted to both fuels. The industry which contemplates investigating off-peak gas rates need not fear high cost and inconvenience during the changeover periods. It should, however, keep in mind that most boilers and their settings are designed primarily for some specific type of fuel other than gas and, therefore, in order to obtain expected economies, fire boxes, baffles, etc., will require careful redesign.

In general gas rates are offered for commercial space heating the year 'round; and, for steam generation, at off-peak periods for power use, such as, for example, in forging hammers. Then there are rates for straight industrial use throughout the year, and

seven-month, off-peak rates for steam generation or water heating.

#### Improved Oil Burners

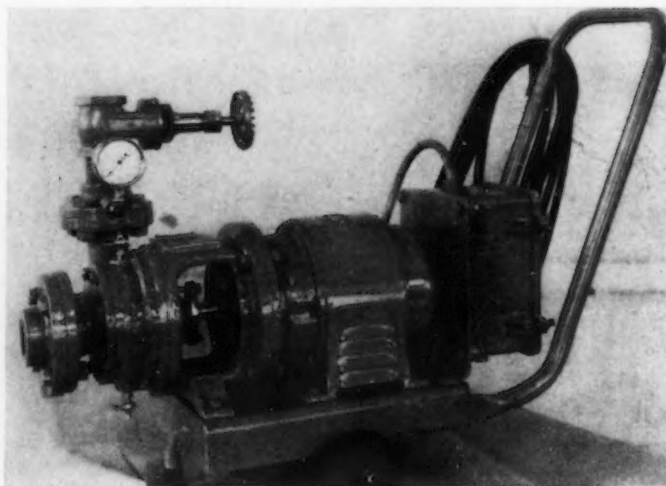
A vast assortment of improved oil burners are available for use in the wide swing from small heating units, through the full range of industrial ovens and furnaces, up to the maximum of power unit requirements. In many instances pulverized coal will fit all economic requirements and here again are offered improved preparation, handling and firing devices, with ever-growing experience in their proper operation.

In recent years growing consideration has been given to the use of diesel-electric units. Their installation is predicated on the

basis of almost equal efficiency in both small and large units which range in size from 10 hp. to 2400 hp. and over. Weight per horsepower has been reduced and satisfactory long life is now to be expected.

Good overall thermal efficiency is to be had when the heat absorbed by the cooling water is used for heating purposes and further economy is possible by means of suitable exhaust or waste heat boilers. A typical industrial installation in the Middle-West consists of two 210-hp. units and a 60-hp. unit. The small unit is used for general purposes, weekend and night loads when the shop is not in production.

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Belling Machines

3 and 4-Way

#### MACHINE TOOLS:

Tapping Machines  
Air Chucks  
Turret Lathes  
Hydraulic Grinders  
Cut-Off Saws

#### FOUNDRIES:

Air Lines  
Sand Blast Machines

Shut-Off

Molding Machines  
Hoists

3 and 4-Way

#### BOILER SHOPS:

Bull Riveters  
Hydraulic-Pneumatic Lifts  
Platen Presses  
Flanging Presses

3 and 4-Way

#### RAILROAD SHOPS:

Acetylene Lines  
Air, Water, Oil Lines

Shut-Off

Hydraulic and Pneumatic Riveter  
Hydraulic and Pneumatic Presses  
Plate Flanging Presses  
Spring Testers  
Banding Presses

3 and 4-Way

#### AUTO INDUSTRY:

Forming Presses  
Hoists  
Machine Tools

3 and 4-Way

Air, Water, Oil Lines

Shut-Off

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makes available about 1,000,000 B.t.u. in the engine cooling water which goes to six fan-equipped shop unit heaters. Two sets of automatically controlled louvers direct heated air to the shop, if needed, or to the atmosphere outside of the building. In this way the unit heaters serve as water coolers, the fans being in operation all the time. Small oil-fired hot-water heaters serve to heat the shop in cold weather when the main units are not in operation.

### Power Conversion at Site

One widely used method of procuring direct-current power is the generation and transmission of polyphase alternating current, and its conversion to direct current at site of application. Until recently conversion was achieved by means of rotating machinery with its inherent disadvantages of noise, vibration, wear, the need for expensive foundations and buildings, and the necessity for supervision and frequent replacement and repairs. The mercury arc power rectifier has been rapidly developed as a substitute for rotating type converters. It is an outgrowth of the glassbulb rectifier which came into use about 30 years ago. Within the last few years the mercury arc rectifier has successfully entered practically all fields of power conversion and there are today approximately 2,500,000 kw. of mercury arc rectifiers installed and on order throughout the world.

The power factor varies between 93 and 96 per cent and it is fairly constant over the entire range. No means of power factor adjustment are available on the rectifier. Voltage drop is practically constant for all loads, a shunt characteristic being obtained due to the combination of rectifier and transformer. Percentage of regulation, which varies between 5 and 7 per cent according to type of transformer connections, is given by the reaction of the transformer.

### Rectifier Applications

As a result of the big increase in current capacity and improvement in load control of rectifiers within the last few years the field of application of the rectifier is now unlimited. The few disadvantages which the rectifier possessed in its early stage of development have been overcome with the result that this converting equipment is

now on a par with all others from the point of view of reliability. It has high overall efficiencies for higher voltages and practically constant efficiency over entire load range; small space requirements; light weight; no special foundation required; low operating costs; low maintenance costs; insensibility to disturbances on a.c. supply system; immunity to chemical fumes, metallic vapors, dust and moisture; no synchronizing necessary; can be operated on any system frequency; high direct current voltages are possible; high instantaneous overload capacity; possibility of cooling entirely by circulating water; and, adaptability to automatic and remote control.

This iron-tank mercury arc rectifier also finds application for variable speed drives for all kinds of industrial purposes. For this use the rectifier is equipped with electrically-energized control grids.

A new development along electrical lines is the synchro-operator, which is a device for automatically paralleling a.c. generators. It finds its most useful purpose in small plants where it removes the uncertainty of synchronizing and therefore supplants the high-grade utility type of experienced operator.

### Welded Piping

The principal development in the matter of piping is the extension of welding, which eliminates mechanical joints not only between the various lengths of pipe, but also where pipes connect to valves. Both pipe and valve makers are beset by the desire of power equipment manufacturers as well as users to go not only to extreme high pressures, but also to new highs in the matter of superheated steam, and joints must be securely made.

Smooth joints and large radius bends have always been desirable as measures to reduce pipe friction. Properly welded joints are an aid in this direction and further they eliminate the uncertainty of mechanical couplings on pipe laid in the ground and they overcome the practical difficulties encountered when pipe lines are subjected to wide ranges of temperatures. It is very common to think of mechanical connections between pipe and valves, but only short reflection will reveal the practical operation of welding a valve in a line, cutting it out with

the torch, if necessary, and re-welding the repaired valve, or a new one in place. Valve manufacturers are meeting these new requirements by furnishing steel valve bodies which are designed to be welded to service lines.

A fine example of this development is afforded by modernizing work performed by the engineers of the Detroit Edison Co. whose pioneering work is applicable throughout all types of industries. This company requires qualification tests of its welders and it has developed standards for a simple butt weld which is sufficient in itself without the use of reinforcing straps. It has studied form of bevel, composition and size of electrode, number of beads, and effects of cleaning, chipping and peening.

A backing ring tacked to the inside of the pipe has been found desirable on large diameter work. Welding-end valves are used in all sizes above 2½ in. Stresses are relieved by an electric induction heating device which is hinged and therefore is quickly and effectively clamped around a pipe weld, and temperatures from 1100 to 1200 deg. F. are attained.

#### Air Compressors

Air compressors of all types and for all purposes have been undergoing steady improvement. Large units applicable for general industrial use are often of the two-stage, double-acting, water-cooled type available for use with electric motors, diesel engines, gasoline or diesel power units, or with integral steam drive.

In that fast-growing area which is now served by natural gas mains, there is good reason for the prospective compressor purchaser to investigate the use of gas in power cylinders. These gas-driven compressors are made in a variety of designs, among them being the multi-cylinder construction which permits the use of small power cylinders thereby reducing weight and lowering maximum loads carried by parts under stress. Arrangement of the power cylinders provides self-balance, which results in use of small flywheels. A step lower in size discloses a wide range of compressors, usually of the horizontal, double-acting type, which are built for heavy-duty and continuous service. Comparatively new in the compressor field are the single-

acting, high-speed, two-stage air-cooled units designed for air pressures up to 125 lb. They require small floor space; water is not needed for cooling, an air-cooled intercooler being placed between the two cylinders; they are well balanced and quiet, and having light weight can be operated on upper floors. The first cost is attractive and the discharged air temperature is low. These units are excellent for use where the heaviest duty is not required, where portability is important, and for out-of-the-way locations. Ball and roller bearings feature this design in which the motor rotor is carried on the compressor shaft. Other than direct-connected motor drives may be specified if desired.

In connection with all air compressor design the drift is toward the elimination of valve impact with resultant comparative quietness of operation.

A compressor manufacturer has developed a two-stage rotary compressor wherein both stages, as well as the intercooler, are contained in a single casing, thereby making a compact unit, and one in which there is only one stuffing box on the low-pressure side, and only one coupling. A special metallic seal is placed between the stages.

#### Pumps

Among new developments by pump manufacturers are the compact, motor-driven centrifugal types in which the pump and the motor are built together as one unit on a single shaft. This construction simplifies assembly, lowers the weight and reduces the purchase price. These units are compact and rugged, and of high efficiency. They are built in one and two stages, in sizes up to 5 in., and ball bearings are used. Capacities range upward to 1000 gal. per min., heads to 240 ft., with motors up to 40 hp. They are, in fact, general purpose pumps as is illustrated by the fact that the rigid and compact design permits slinging them from chains or ropes for emergency pumping service.

General service, single-stage, double-suction pumps are now commonly assembled with heavy-duty ball bearings which are capable of carrying large thrust loads in either direction. Other new lines of centrifugal pumps

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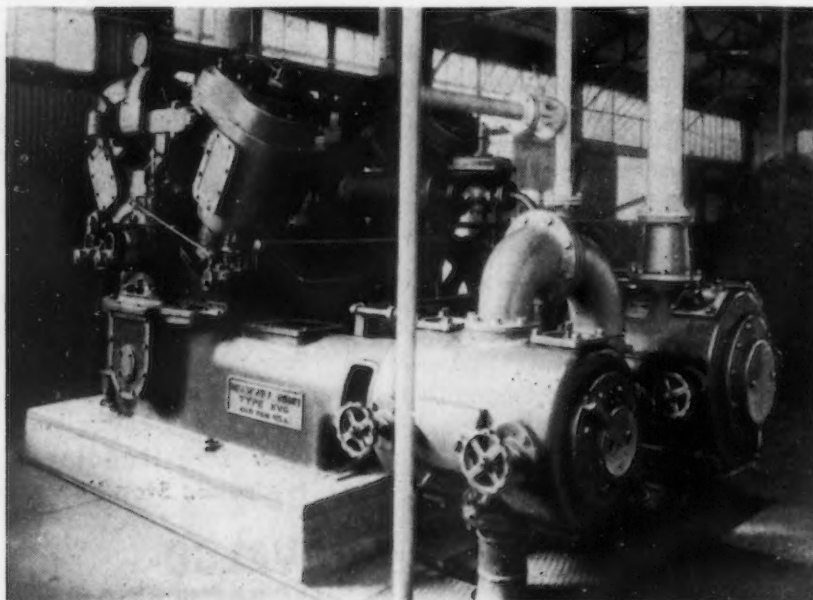
44 Years of Service to Industry

are designed for high speeds up to and including 3600 r.p.m. Typical of this design are two-stage units, of capacities ranging upward to 1000 gal. per min., and for heads up to 450 lb. These pumps are offered for boiler feed and general service. Construction features include the reduction of fluid friction by machine polishing or by handworking all accessible surfaces. Impellers are balanced,

handling in the heavy industries for many years. However, it is only within the past few years that marked changes in design and construction have been developed. One of these is the substitution of herringbone gears for the plain spur-toothed gear. This has resulted in fewer reductions for a given speed, which in turn means fewer bearings, lower power consumption, and smooth and quiet

Great progress in welding has resulted in the adoption of many welded parts in modern bridge crane design and there are cranes fabricated with all welded bridges. Other builders adhere to the riveted girder, but use welded steel end trucks and welded trolley frames. The main advantage of the welded construction is reduction of weight without sacrifice of strength. A fine example of all-welded construction is the 200-ton main erecting crane in the shop of the Electro-Motive Corp., McCook, Ill. This crane weighs 205 tons and it handles the large diesel-electric locomotives which are used on modern high-speed, streamlined trains.

All of the above changes are reflected in more simple design and more compact arrangement of working parts, making for greater ease of inspection and maintenance. Lubrication is important on any piece of machinery, especially on an overhead crane. A major improvement of recent years is the adoption of welded gear boxes, completely inclosing the gear reductions and filled with oil so that gears and bearings are splash lubricated. Dust and dirt are kept out and the life of the gearing much prolonged. By having all



shafts are made of heat-treated steel, and large heavy-duty ball bearings are mounted in dirt and grease-tight housings. The out-board bearing is designed to carry an unusually large thrust load in either direction.

High-speed, 3600 r.p.m., boiler feed pumps for use with pressures up to 600 lb. are of the multi-stage, single-suction, opposed-impeller type. Heavy-duty ball bearings take the thrust load in either direction and the other end of the shaft is supported on a self-aligning type of ball bearing. High speed leads to high pump efficiency, a small driver with resultant reduction of floor space, weight and power cost. This type of pump is hydraulically balanced by placing an equal number of impellers back to back.

#### Electric Cranes

The electric traveling crane has been a major factor in materials

operation. Another feature is the application of roller bearings, which have added much to the ease of operation and lowered maintenance costs. Some cranes are now furnished with roller bearings throughout.

gears completely inclosed, safety is greatly increased.

#### Brake Cooling

Another recent and very important development in crane construction is that of oil-cooling the

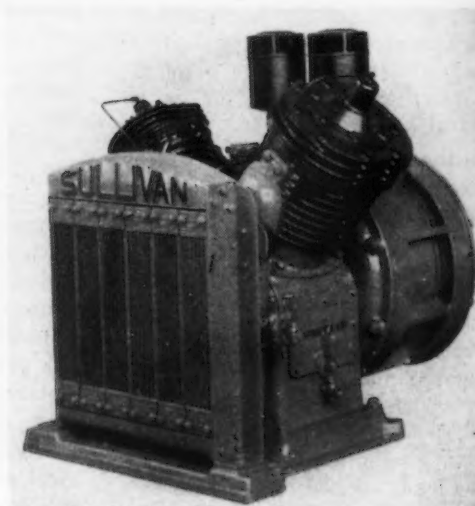
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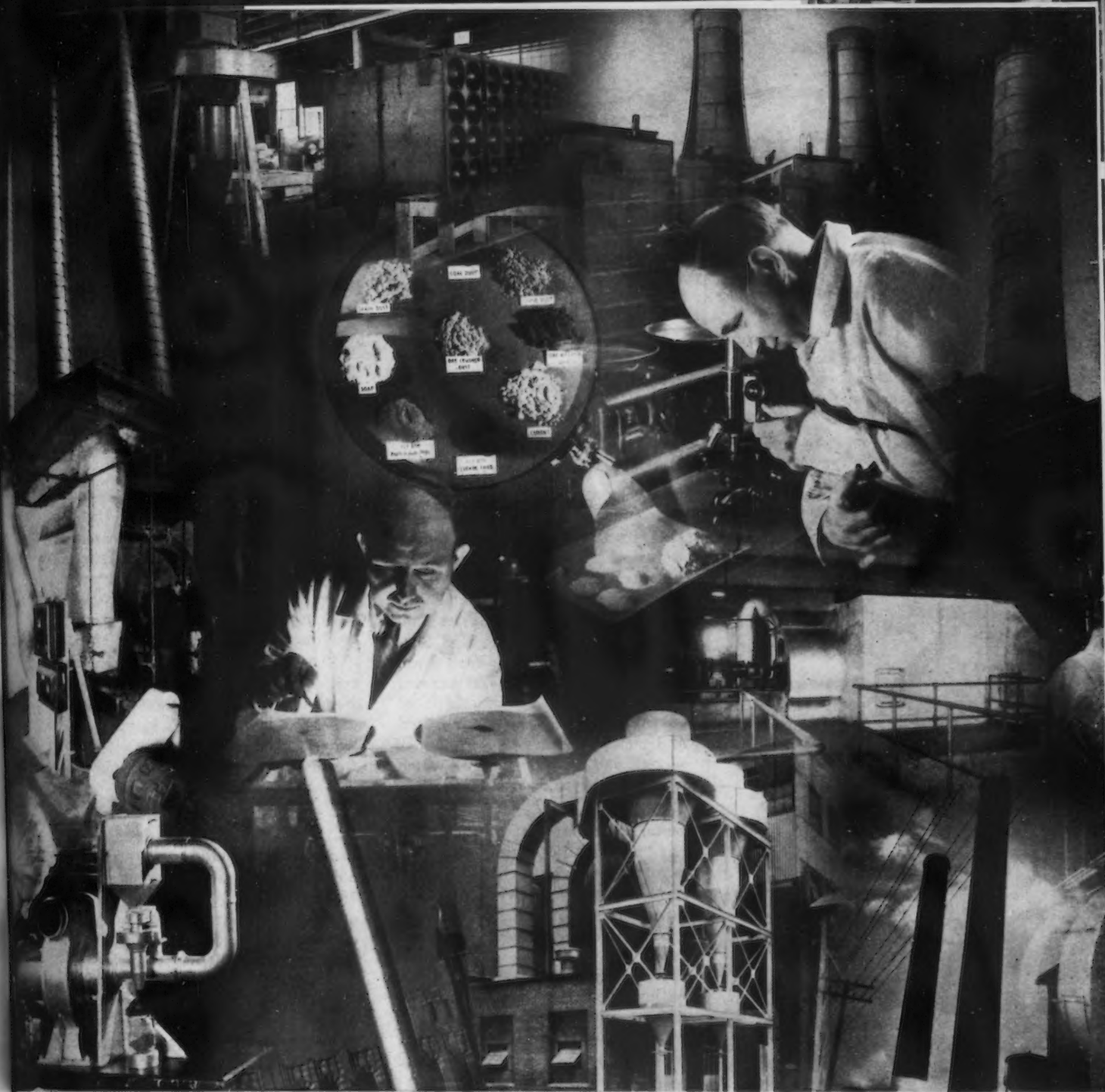
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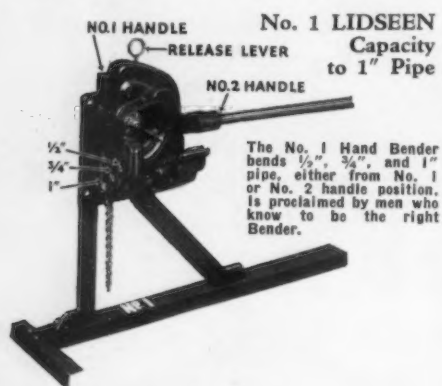
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automatic load brake used on alternating-current cranes. The function of the automatic load brake is twofold, that of holding the load, and that of changing the potential energy of the suspended load into heat. In order to get this generated heat away from the friction parts quickly, oil is pumped between the friction disks. This development is effective in increasing the capacity of the crane and obtaining a long life for the friction disks. Still another development is the use of speed reducer inclosures, which provide a bearing on each side of the motor pinion thereby eliminating heavy loads on the motor bearings.

Hoist manufacturers are alert to the growth of the urge to move materials fast and conveniently. An extremely wide variety of types and sizes are now available for mounting on hooks or to be suspended from a trolley or jib. Special design attention has been given to reduction of parts and general operating ruggedness, methods of control, service adjustments, dust and moisture proofing for outdoor service, and braking methods which permit stops without jerking.

Contributing to the economy of material movement are ever-expanding types of trucks and conveyors into which their builders have put wide experience. Portable conveyors of the bucket and belt type illustrate how some problems are solved not alone as a matter of speeding movement and eliminating back-breaking jobs, but as a most effective means of solving what is an acute labor shortage which does not give immediate signs of material improvement.

### Gas Tractors

For general use about manufacturing buildings are gasoline engine driven tractors, which are capable of economical and fast movement of trains of box-body and other types of trailers. Storage battery types of trucks offer an extremely wide variety of uses

such as hauling loads, and carrying loads on low-lift platforms. High lifts afford special economies where products are to be tiered or stacked. Other modifications are designed for special purposes, such as for the convenient pick up and transport of coils of strip and wire.

Typical of features offered in the gas tractor field are light running speeds of 10 miles per hr. and maximum sustained draw-bar pull of 3000 lb. in low gear at 1.25 miles per hr. Four-cylinder motors, four-speed transmission, internal expanding type brakes, pneumatic or solid tires, power take-off and headlights are all available. For heavy-duty service about the industrial yard there are the gasoline and diesel engine powered units which are commonly in use by contractors. Wheels may be lugged or provided with pneumatic tires, or the tractor may be of the crawler type.

Shockless steering, centralized control, improved spring suspension, higher speed, greater operating efficiency, and many improved safety features are to be found on the new electric types of trucks.

### Crawler Units

An interesting and important drift in the handling of yard and bulk materials is the turn away from the old locomotive crane, operated on railroad tracks to the crawler type unit which is practically unlimited in its area of movement. In many plants tracks are being taken out. Crawler type cranes are loading trucks with minimum needs for roadways, the extreme of flexibility, and increased storage space of as high as 25 per cent resulting from use of the dead space heretofore occupied by tracks. The saving runs particularly high in plants where roadways paralleled tracks.

All of the above developments and improved practices are available to contribute their share toward lower costs. They should be fully investigated.

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# FOUNDRY EQUIPMENT AND SUPPLIES

*Tailor-made castings, in which the mix as well as the method of making is dictated by intended use of the product, are features of 1936 foundry progress.*

By T. G. JOHNSTON

*Metallurgical Engineer, Pig Iron  
Division, Republic Steel Corp.*

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• • •

THE trend of modern practice in the foundry industry today is to produce the best castings for the particular services for which they are intended, to make them at the lowest cost possible and with qualities that will give them the longest life in order that they may compete successfully with other products.

Much better castings are being made than a few years ago because the improvement in foundry practices with the close cooperation between producers and consumers

of pig iron has lifted its production and consumption to much higher levels. Alloy castings have been wonderfully improved in strength, machineability and in wearing qualities by the proper addition of alloys. Life of castings has been increased to such an extent that some manufacturers are giving a 20-year guarantee for heat-resisting alloy castings.

The foundry industry today faces keener competition than in the past from steel and concrete and this has made it necessary for makers of certain types of gray iron castings to reduce manufacturing costs and selling prices and to furnish a product that will meet the initial cost of steel and other competitive materials. Not only

have foundries been able to meet this competition, but they are furnishing a product that has a much longer length of service.

Foundrymen today are in better position not only to make castings of a better quality than a few years ago, but to obtain better prices for quality products. For some particular uses it has been proved that castings with an alloy content gave longer life and better service. There is also a marked improvement in strength and wearing qualities of castings containing no alloys but which are produced with various types of mixtures, some containing steel scrap and others without steel scrap.

These improvements in the qualities of castings containing no

alloying elements have been brought about by the use of the best materials and by following the best foundry practices. The larger foundries now have their own research departments, laboratories and physical testing equipment which have helped to improve the foundry industry in all its phases. A great many small foundries that do not have laboratory equipment obtain a great amount of help both from suppliers of raw materials, from literature of the various foundry associations and from attendance at meetings conducted by local chapters which are addressed by practical foundrymen and often leaders in the industry.

The modern trend in foundry practice, as well as in steel, has been to make castings with lighter weight and thinner sections than heretofore and to obtain not only as much strength, but increased strength, as compared with heavier castings for similar uses. By improved methods, the use of alloys, and by charging steel scrap in the cupolas, the weight of castings in some cases has been decreased one-half and the strength almost doubled.

Alloy cast iron is made by adding nickel, chromium and molybdenum according to the specifications of the customer or as decided upon by the foundrymen as best suited for the type of castings that are being made. However, adding alloys in the cupola or in the molten metal in the ladle does not always assure the desired amount of alloy in the finished casting unless the alloy is properly used.

It has been found by chemical analysis in some cases in which alloy additions were made for special requirements that there was practically no alloy in the casting. In these cases the alloys have been an expense for the foundryman and the customer does not get the results he desired and has paid for. However, cases of this kind are not generally found in foundries having their own laboratories, but usually in foundries having only occasional analyses of their iron made.

#### Automotive Branch Progressive

More progress has been made during the past six years in foundries operated by automobile manufacturers and also foundries which supply castings to this trade than



**S**AND cast pig iron as formerly made.

in any other branch of the foundry industry. This is due largely to the vast amount of research work which has been done, installation of modern equipment of all kinds and close supervision of all details from purchasing of raw materials to finished casting ready for use.

In foundry operations today more attention is being paid to the materials charged in the cupola. With the modern method of casting pig iron on casting machines the physical structure of the pig is much cleaner, and because of recent improvements the grain structure is controlled and is more uniform. A number of the larger producers of pig iron are now making pigs of approximately half the weight of those formerly used. This new type of pig has been accepted by foundrymen and found very satisfactory in that it is easier to handle and has tended to improve operating conditions.

In the old type of sand cast and chilled cast pig iron there were variations in the weights of pigs from 50 to 200 lb. Within the past 10 years there has been a decided trend toward reducing the weight to between 30 and 50 lb. This size and type of pig as compared with the large pigs has a decided improvement in grain structure and cleanliness. As a result of this cleanliness, waste in handling is almost entirely eliminated. Another important advantage of the smaller sized pigs is that their use has resulted in a marked reduction in the number of accidents that occurred where pigs were handled by hand.

Where pigs of smaller and more

uniform size are used, the cupola control has been greatly improved through charging into the cupola material that is more uniform in size with the size of the pigs. Use of the smaller pigs has caused foundrymen to use scrap of lighter weight or smaller sections. With cupola charges of the smaller pigs and lighter scrap, melting conditions are better and the analysis of the molten iron is more uniform.

Pigs in the smaller sizes are more easily charged into the cupola, are melted with less coke and melted faster than when the old type of sand cast and chilled pig iron with variations in weight was used.

A marked advance has been made in charging cupolas by the use of mechanical charging equipment which is provided in practically all new foundries. Mechanical charging assures better distribution of the charge and reduces accident hazards.

#### Pig Iron Bought on Definite Analysis

Foundrymen, instead of buying iron on a fractural grading as formerly, with silicon the only element that was given much consideration, today purchase it on a definite analysis basis, showing the silicon, sulphur, phosphorus and manganese content. The required content of these elements varies according to the type and kind of castings that are to be produced, ranging from the smallest automobile piston ring to castings weighing up to 50 tons.

Opinions differ even among



**C**HILLED pig iron as it was formerly made.

foundrymen as to the analyses of iron required for making light and heavy sections. These differences of opinion to a considerable extent are due to the varying amounts of steel scrap and other alloys that are added to give the castings the required strength. Some foundrymen think that costs can be reduced and as good castings can be produced by using low-silicon foundry iron and adding high-silicon silvery iron or ferrosilicon. The additions to the pig iron are variable, usually being determined by the cost of the mixtures or the price of the scrap obtainable in the territory in which the foundry is located in comparison with the price the foundry has to pay for pig iron.

Foundrymen today are paying more attention to having the best quality of foundry coke and a great saving can be effected both by using the best grades of coke of proper size and also by using the proper amount of coke to melt the iron to the temperature desired. The coke charge is controlled by the temperature of the iron and the kind of castings that are to be made from the metal.

Practically all foundry coke today is made in modern by-product ovens. However, due to the increased demand for coke and to the greater use of coke for domestic use many old type beehive coke ovens are being repaired and put in use for making blast furnace and foundry coke. With proper coals very satisfactory foundry coke can be made in beehive ovens.

To get the best results the

cupola bed should be thoroughly ignited and also should be of the proper height, according to the size of the cupola and the tuyere area. This bed of coke should be maintained during the entire heat to get uniform results and good hot iron. The cupola may be slagged either from the back or front, but as much slag as possible should be removed from the molten metal to obtain the best results.

#### Higher Melting Temperatures

In foundry cupola practice there is a trend toward melting iron at a higher temperature than formerly, the present temperature range being 2600 to 2900 deg. F. In the malleable iron industry, where particularly high pouring temperatures are required, the iron in some foundries is tapped into duplexing furnaces to increase the temperature. Temperature of metal from the cupola is controlled by the amount of coke and the volume of air. After the iron is melted it must be poured hot to obtain the best results, especially when making thin section castings and automobile cylinder blocks.

The modern trend in foundry practice is to pour iron as hot as possible in order to produce the best quality castings and also a trend to make the molds to suit the temperature of the iron rather than to pour iron at a temperature to suit the molds.

The maximum temperature of iron is controlled by the types of castings. While there is no definite control in the blast furnace of elements other than silicon, sulphur, phosphorus and manga-

nese, the carbon content of the cupola metal is necessarily controlled by the addition of steel scrap to the cupola charge, by the method it is melted and the time the molten iron is held in the cupola.

Some gray iron foundries use a fore-hearth holding two to six tons for mixing molten iron and also for desulphurizing the molten metal. Others tap the approximate weight of one cupola charge of metal in each ladle. Others carry reservoirs of molten metal in the cupola, which gives a uniform mixture of the materials charged. Ladles should be thoroughly dried hot and cleaned to give best results.

For making good castings, not only the best possible mixture is required but the right kind of sand for molding and making the cores. In the larger foundries today that have the best supervision the molding and core sands are of vital importance, because a molder, no matter how good he may be, cannot get good results with sand too low in permeability or having a grain structure not suited for the type of casting that is being made.

#### Sand Control Important Factor

For this reason, sand control has become a very important factor in the foundry industry. Control of sand in present-day foundry practice is much better than in the past. Sand tests are made every 30 min. to keep the sand in proper condition in the larger production foundries where molding and pouring are continuous.

Less new sand is required today because the methods of conditioning the sand for molding have been improved by the use of mechanical equipment for preparing the sand, formerly done by hand. This equipment not only prepares the sand for various uses, but also removes fins, scrap, and other foreign material which, if not removed, result in bad castings. During this conditioning the proper amount of moisture is added. The sand conditioned with modern equipment is not only better for hand molding, but also for the various types of machine molding. Without this equipment it would be impossible to use foundry sand as many times over as it is necessary to use it in production foundries.

# Yesterday, a Trade— —Today, a Science

**T**IMES have changed in the foundry. And much for the better.

Gone, at least so far as successful foundries are concerned, are the "rule of thumb" days when making castings was a trade and not a science.

Today, successful foundry managers are more likely to have degrees in metallurgy than to be graduates of the hard school of sand pounding.

Foundrymen have found that there is not much profit in competing with several hundred other foundries on a price per pound basis. And they have discovered that the way to take themselves and their product out of this deadly level of competition is through specialization.

Thus, alloy iron in castings is fast treading on the popular heels of alloy steel.

The successful foundryman *must* keep himself well informed on metallurgical developments. That is why successful foundry executives read The Iron Age.

And that, in turn, is a very good reason why The Iron Age is a very good medium for those who wish to sell their products to successful foundrymen.

**THE IRON AGE**

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Sand Mixers



Jeffrey Mold Conveyor installation in a high production Foundry



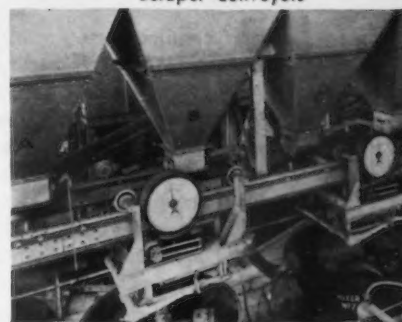
Pendant Type Mold Conveyors



Swinging Chute Type Flask Fillers



Scraper Conveyors



Charging Sand Mills by weight in a Jeffrey Sand Conditioning System



Overhead Bin Type Flask Filler



Automatic Batching of Sand Mills

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Jeffrey takes the field in 1937 better equipped than ever to reduce operating costs in the foundry.

Even more diversified than before, our line of material handling and sand conditioning equipment gives us more flexibility in the selection of the proper equipment for your particular needs. Our experience in making many important modern installations in the last few years is available to you.

The many foundries that have modernized the Jeffrey way have learned that Jeffrey handling systems, units and products are properly designed and applied and pay big profits. Let us send you a list of a few of these plants.

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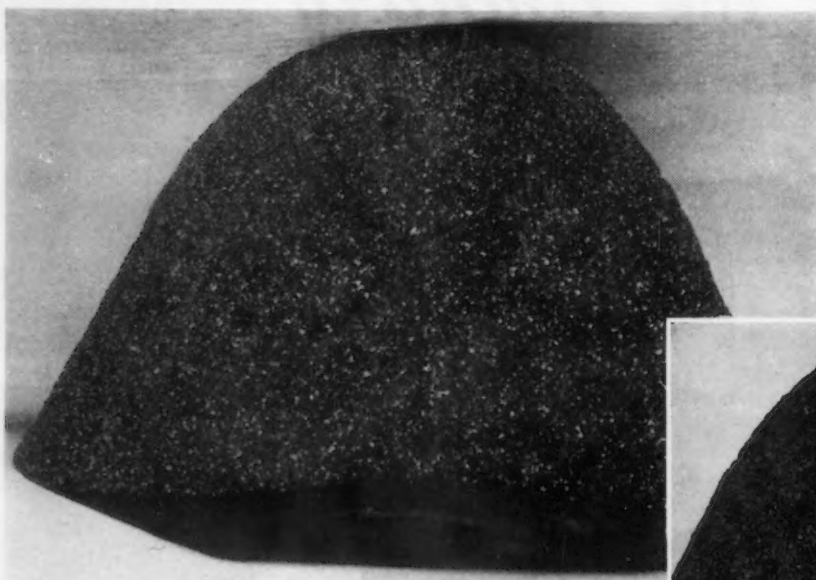
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ABOVE

**N**EW style of pig iron cast in small pigs showing uniformity in grain structure and size of grain.

Use of mechanical sand handling and conditioning systems for mixing and tempering sand not only reduces the cost of sand for molds and cores, but makes much closer control possible. With sand properly conditioned mechanically, castings are much more easily cleaned and of better quality than when hand sand-mixing methods are employed.

With modern core room equipment and drying ovens, cores of much better quality are being made and at lower cost than formerly.

This progress in core making has been brought about by the use of improved core making equipment and also by having improved core drying equipment with which cores are dried in three or four hours instead of the over-night drying formerly required.



**T**HIS shows the non-uniformity of grain structure in pig iron cast in the larger sizes.

is that losses due to bad castings are much less than when these machines were not used. Molding machines are being used for all classes of work where possible. Manufacturers of molding machines have worked with the foundry industry in developing new equipment which has made possible the large production and quality castings and which also has enabled foundrymen to control closer the weight of castings by having better made molds.

Cleaning of castings has also been improved by modern cleaning equipment and, whether the castings are sold in a rough state or machined, the use of modern cleaning equipment gives them a cleaner surface, reducing both machining costs and wear on machine tools. Improvements in cleaning equipment during the past few years have resulted both in better and more rapid cleaning.

Even during the period of depression, close competition between foundries led them to equip their plants with efficient cleaning equipment and the business of manufacturers of that type of equipment in those years equalled

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in volume that of the prosperous years of 1925 to 1929.

Cleaning castings with shot blast and sand blast gives them a cleaner surface and minor defects are brought out which otherwise might not be noticed. By discovering these defects foundries are able to find and eliminate their cause. Many small castings are cleaned in tumbling mills and many by the sand-blast and shot-blast methods.

#### General Working Conditions Improved

Foundry conditions are constantly being improved from the standpoint of health and workmanship by better lighting and dust collecting equipment and these improvements have tended to improve the

collecting equipment, but the more progressive foundry operators have found that, even if laws do not require the elimination of foundry dust, workmanship is improved and better castings are produced if good working conditions are provided by eliminating dust and fumes from the foundry. Dust collecting systems have been materially improved.

In the construction of new foundries today, particular attention is being given in designing the buildings to provide adequate lighting both from the outside and from within. Castings made in a well lighted foundry are cleaner than those made in one that is dark. Thus an abundance of light supplements the work of the modern casting cleaning equipment.



**C**HILLED pig iron as it is now being produced in small pigs. This shows the uniformity in size and cleanliness. These small pigs are easier to handle and accident hazards from handling are reduced because of the small size.

quality of the work. The quality of castings produced in many cases is directly in comparison with the efficiency of the foundry equipment, the lighting and ventilation of the plant. The dirty, poorly lighted foundry that was quite common a few years ago is rapidly being replaced by a foundry that has made at least some progress toward air conditioning. When labor is not plentiful molders and other foundry labor will leave a dirty, smoky foundry to secure employment in one where working conditions are better.

Some States have enacted laws requiring the installation of dust-

Today some progressive foundrymen who do not have modern plants and who are unable to replace present foundries with new buildings are painting the interiors of their foundries with aluminum paint to improve the lighting of these dark and dirty buildings. This is being done once a year or oftener in some foundries.

With the trend of modern foundry practice the time is not far distant when air conditioning will be provided in well operated foundries, as it is today in offices and homes. Some foundries have already led the way in providing air conditioning equipment.



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